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Lyndon B. Johnson Space Center

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Hardware Requirements Document (HRD)
for the
Human Research Facility
Refrigerated Centrifuge

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Hardware Requirements Document (HRD)
for the
Human Research Facility
Refrigerated Centrifuge

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Preface

This Hardware Requirements Document (HRD) defines the minimum set of requirements for the Refrigerated Centrifuge to be placed on the International Space Station (ISS) and mounted within the Human Research Facility (HRF) Rack. This document is under the control of the HRF Configuration Control Board (CCB).

HRF CCB Chair DATE

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ACRONYMS AND ABBREVIATIONS

A	Amperes
AC	Alternating Current
ADP	Acceptance Data Package
ANSI	American National Standards Institute
AVT	Acceptance Vibration Testing
ºC	Degrees Celsius
C&DH	Command and Data Handling
CCB	Configuration Control Board
CCSDS	Consultative Committee for Space Data Systems
CG	Center of Gravity
cm	Centimeters
COTS	Commercial-Off-the-Shelf
CSCI	Computer Software Configuration Item
dB	Decibels
dBA	Acoustic Decibel Level
DC	Direct Current
dia.	diameter
DR	Discrepancy Report
DRD	Definition Requirement Document
EVA	Extravehicular Activity
EEE	Electrical, Electronic, and Electromechanical
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EPCE	Electrical Power Consuming Equipment
ESD	Electrostatic Discharge
EXPRESS	Expedite the Processing of Experiments to Space Station
ºF	Degrees Fahrenheit
FIAR	Failure Investigation Analysis Report
FRD	Functional Requirements Document
ft	Feet
g	Gravity
GASMAP	Gas Analyzer System for Metabolic Analysis of Physiology
GFCI	Ground Fault Circuit Interrupter
GHz	Gigahertz
GIDEP	Government and Industry Data Exchange Program
GPVP	Generic Payload Verification Plan
grms	gravity, root mean square
GSE	Ground Support Equipment

HR	Hazard Report
HRD	Hardware Requirements Document
HRF	Human Research Facility
Hz	Hertz
ICD	Interface Control Document
ID	Identification
IDD	Interface Definition Document
IEEE	Institute of Electrical and Electronic Engineers
IMS	Inventory Management System
in	Inch
ISIS	International Subrack Interface Standard
ISS	International Space Station
ITCS	Internal Thermal Control System
IVA	Intravehicular Activity
JSC	Johnson Space Center
kg	Kilograms
kHz	Kilohertz
kPa	kilopascal
lb	Pound
lbf	pounds force
µsec	Microseconds
MDM	Multiplexer-Demultiplexer Module
MDP	Maximum Design Pressure
MHz	Megahertz
mil	thousandths of an inch
MIL-ER	Military Established Reliability
min	Minutes
ml	Milliliters
mm	Millimeter
MOTS	Modified-Off-the-Shelf
MPLM	Mini Pressurized Logistics Module
msec	Milliseconds
MSFC	Marshall Space Flight Center
MTL	Moderate Temperature Loop
MUA	Material Usage Agreement
N	Newton (metric force measurement)
N/A	Not Applicable
NASA	National Aeronautics and Space Administration

NSTS	National Space Transportation System (Do not use—use SSP)
NTSC	National Television Standards Committee
oct	Octave
ORU	Orbital Replacement Unit
Pa	Pascal
PDA	Pre-Delivery Acceptance
PFE	Portable Fire Extinguisher
PIA	Payload Integration Agreement
P/L	Payload
PRD	Program Requirements Document
psi	pounds per square inch
psia	pounds per square inch absolute
PU	Panel Unit
PUL	Portable Utility Light
PVP	Payload Verification Plan
QAVT	Qualification for Acceptance Vibration Testing
QEPM&L	Qualified Electrical, Electronic, Electromechanical Parts, Manufacturers, and Laboratories
QSI	Quality System Instruction
QVT	Qualification Vibration Test
Rad	Radiation Absorbed Dose
RC	Refrigerated Centrifuge
RIC	Rack Interface Controller
RMA	Rack Mounting Adapter
rms	Root Mean Square
RPM	revolutions per minute
SE&I	Systems Engineering and Integration
S&PA	Safety and Product Assurance
sec	Second
SEE	Single Event Effect
SIR	Standard Interface Rack
SOW	Statement of Work
SPL	Sound Pressure Level
SSPC	Solid State Power Controller
SWTP	Software Test Plan
TBD	To Be Determined
TM	Technical Memo

TPS	Task Performance Sheet
TRR	Test Readiness Review
UIP	Utility Interface Panel
UOP	Utility Outlet Panel
V	Volts
VC-S	Visibly Clean - Sensitive
Vdc	Volts, direct current
VDS	Verification Data Sheet
VES	Vacuum Exhaust System
VRS	Vacuum Resource System
WTSF	White Sands Test Facility

1.0 SCOPE

This specification defines the Human Research Facility (HRF) program requirements for Refrigerated Centrifuge. The Refrigerated Centrifuge (RC) is a complex subrack payload that will be used to support the HRF.

The primary governing document for the requirements levied in this document is LS-71000, Program Requirements Document for the Human Research Facility. Other requirements are derived from the experiment unique interface definition documents for the various items of HRF equipment.

The requirements in Sections 3, 4, and 5 of this document consist of a minimum set of constraints for the Refrigerated Centrifuge hardware and software. Hardware Criticality is defined in the table in Section 3.2 of LS-71000.

The HRF Project Office is the controlling authority for this document. The HRF Configuration Control Board (CCB) or a delegated authority must approve any deviations from the requirements of this document.

2.0 APPLICABLE DOCUMENTS

The following applicable documents of the exact issue shown herein form a part of this specification to the extent specified herein. If a revision level or date is not cited, the latest version of the document should be used.

All specifications, standards, exhibits, drawings or other documents referenced in this specification are hereby incorporated as cited in the text of this document.

2.1 DOCUMENTS

Document Number	Revision	Document Title
ARC/BRP-40006	A	SSBRP Laboratory Support Equipment
D683-43631-1		EXPRESS Payload Software Interface Control Document - Human Research Facility
FED-STD-595	B	Colors Used in Government Procurement
JPD 5335.1		JSC Quality Manual
LS-71000	Draft 10/00	Program Requirements Document for the Human Research Facility
LS-71001	A	Functional Requirements Document for the Human Research Facility
LS-71010		Fracture Control Plan for the Human Research Facility
LS-71011		Acoustic Noise Control and Analysis Plan for Human Research Facility Payloads and Rack
LS-71016		Electromagnetic Compatibility Control Plan for the Human Research Facility
LS-71020	A	Software Development Plan for the Human Research Facility
LS-71026	Draft 12/97	Human Research Facility Reliability Plan for the HRF Workstation Racks
LS-71030	Draft 10/97 Ch. 1	Quality Assurance Plan for the Human Research Facility
LS-71083		Software Design Document for the Human Research Facility

Document Number	Revision	Document Title
LS-71083-2	Draft	HRF Refrigerated Centrifuge Interface Definition Document
LS-71083-3	Draft	HRF Refrigerated Centrifuge Software Test Plan
MIL-S-33540		General Specification for Liquid Locking Compounds
MIL-STD-1686	C	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies And Equipment (Excluding Electrically Initiated Explosive Devices)
MSFC-STD-531		High Voltage Design Criteria
NASA TM 102179	6/91	Selection of Wires and Circuit Protective Devices for STS Orbiter Vehicle Payload Electrical Circuits
NSTS/ISS 13830	C Ch. 1	Implementation Procedure for NSTS Payloads System Safety Requirements for Payloads Using the Space Transportation System
NSTS/ISS 18798	B Ch. 3	Interpretations of NSTS/ISS Payload Safety Requirements
NSTS-1700.7	B Ch. 4	Safety Policy and Requirements for Payloads Using the Space Transportation System
NSTS-1700.7B ISS ADDENDUM		Safety Policy and Requirements for Payloads Using the International Space Station
NSTS-21000-IDD-MDK	B Ch. 2	Shuttle Orbiter/Middeck Interface Definition Document Cargo Element Interfaces
SN-C-0005	C	National Space Transportation System Contamination Control Requirements
SP-T-0023B	B	Environmental Acceptance Testing Specification
SSP 30233	F	Space Station Requirements for Materials and Processes
SSP 30237	E	Space Station Electromagnetic Emission and Susceptibility Requirements
SSP 30240	C	Space Station Grounding Requirements
SSP 30242	E	Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility

Document Number	Revision	Document Title
SSP 30243	E Ch. 3	Space Station Requirements for Electromagnetic Compatibility
SSP 30245	D	Space Station Electrical Bonding Requirements
SSP 30257		Multiple Listings
SSP 30312	G	Electrical, Electronic, and Electromechanical (EEE) and Mechanical Parts Management and Implementation Plan International Space Station Program
SSP 30512	C	Space Station Ionizing Radiation Design Environment
SSP 30695	A	Acceptance Data package Requirements Specification
SSP 41017	B	Rack to Mini Pressurized Logistics Module Interface Control Document (ICD) Part 1
SSP 50005	B Ch. 1	International Space Station Flight Crew Integration Standard (NASA-STD-3000/T)
SSP 50007	A	Space Station Inventory Management System Label Specification
SSP 52005	B	Payload Flight Equipment Requirements and Guidelines for Safety-Critical Structures
SSP 52050	A	Software Interface Control Document Part 1, International Standard Payload Rack to International Space Station
SSP 57000	E	Pressurized Payloads Interface Requirements Document
SSQ-25002	A Ch. 6	Supplemental List of Qualified Electrical, Electronic, Electromechanical (EEE) Parts, Manufacturers, and Laboratories

2.2 ORDER OF PRECEDENCE

In the event of a conflict between the text of this specification and references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3.0 SYSTEM REQUIREMENTS

3.1 ITEM DEFINITION

The following items of RC hardware will be designed and certified under this requirements document for use on International Space Station (ISS) as a part of the HRF program. The HRF Rack hardware used with this hardware is certified under separate documentation which is maintained by the appropriate program(s).

Table 3.1-1 lists the equipment items covered by this document including the stowage kits that will be used to transport the items and contain the items on-orbit. The items shown in the following table are for reference only. Only the items listed as Class I will be built in accordance with this document.

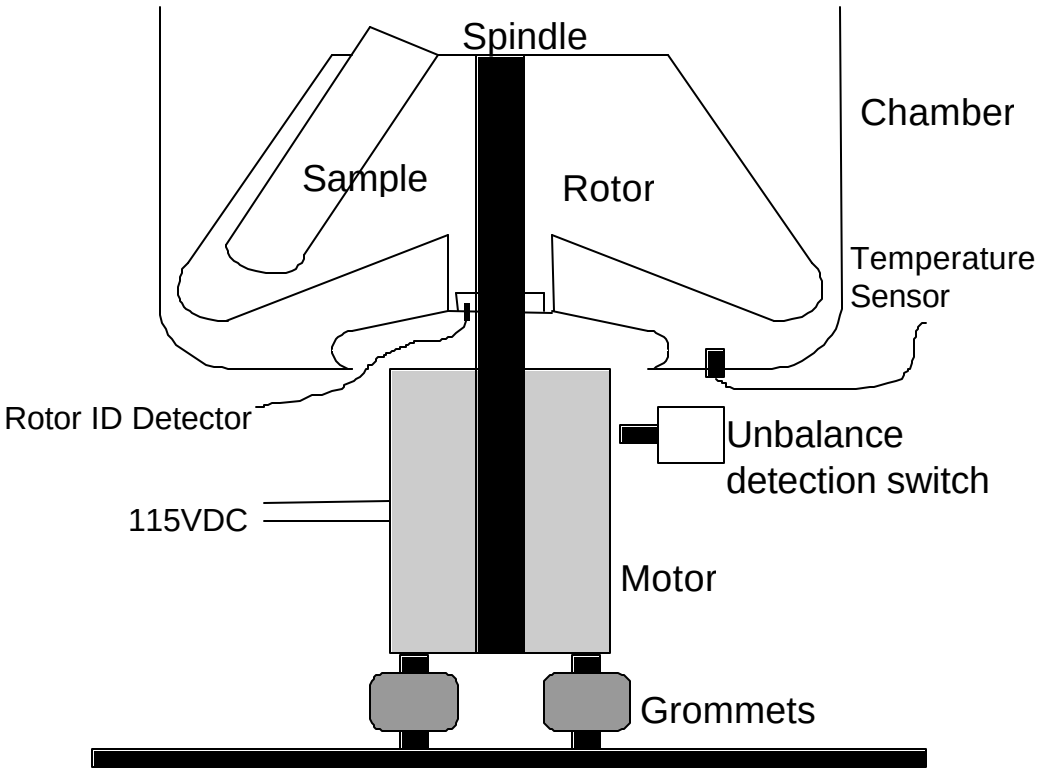
TABLE 3.1-1. EQUIPMENT ITEMS

Item Name	Part Number	Class	Quantity	Notes
Mikro 22R	1110-01	III	1	Evaluation Unit
Refrigerated Centrifuge	SEG46117400-301	III	1	Prototype
Refrigerated Centrifuge	SEG46117400-301	II	1	Qual. Unit
Refrigerated Centrifuge	SEG46117400-301	I	2	Flight Units
Refrigerated Centrifuge	SEG46117400-301	III	1	Trainer

3.1.1 Description

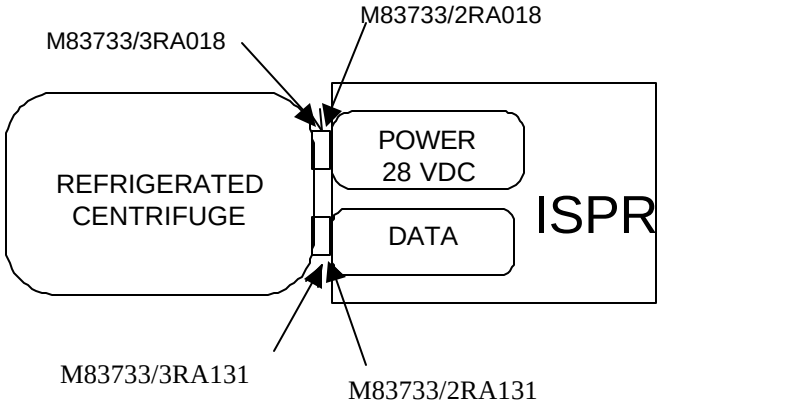
A centrifuge is a mechanical device used to separate substances of different densities. Centrifuges may be used to quickly separate substances that would normally separate slowly under the influence of gravity. The RC is intended to provide a system of separation of biological samples based on differing sample densities in a controlled temperature environment. The centrifuge will be capable of separating blood into its components and separating saliva from saturated dental cotton rolls. The RC will be a Modified-Off-the-Shelf (MOTS) centrifuge, repackaged into a 12 Panel Unit (PU) drawer (see Figure 3.1.1-1 for the Functional Block Diagram). The drawer will utilize three connectors from the rear of the rack. (Reference Figure 3.1.1-2 for the Interface Block Diagram.) The RC will provide performance data as well as some hardware health data. The data will be transmitted via ethernet to the Rack Interface Controller (RIC).

The RC consists of two main components: 1) the refrigeration system and 2) the rotor assembly.



CENTRIFUGATION - FUNCTIONAL BLOCK DIAGRAM

Figure 3.1.1-1. Functional Block Diagram



RC ELECTRICAL INTERFACE DIAGRAM - RACK MOUNTED (12PU DRAWER)

Figure 3.1.1-2. Interface Block Diagram

3.1.1.1 Refrigeration System

The refrigeration method utilized by the centrifuge is vapor compression cycle. Vapor compression systems consist of four components: a compressor, a condenser, an evaporator, and an expansion device (see Figure 3.1.1.1-1).

The compressor takes low pressure, low temperature refrigerant gas and compresses it to high pressure, high temperature gas. The compressor accomplishes this in a manner similar to that of an automobile engine. Reciprocating pistons intake vapor at low pressure and compress the vapor before sending it to the discharge line. The cool, low pressure gas entering the compressor is referred to as suction gas. The high pressure, high temperature gas exiting the compressor is called discharge gas. The existing compressor relies on oil sumping at the bottom of the compressor to lubricate the gears and therefore is gravity dependent.

From the compressor, the hot, high-pressure gas travels through the discharge line into the condenser. The condenser is the part of the system where the heat is rejected by, as the name implies, condensation. An everyday example of condensation is a container of cold water left outside on a hot summer afternoon. Since the surface of the container is cooler than the air that surrounds it, water begins to leave the air and form drops on the container. As the water condenses from the air onto the surface of the container, it loses energy and therefore cools. In the vapor compression system, as the hot gas travels through the condenser, it is cooled by air passing over it. As the hot gas refrigerant cools, drops of liquid refrigerant form within the coil.

Eventually, when the gas reaches the end of the condenser, it has condensed completely, that is, only liquid refrigerant is present. Just like the water condensing onto the surface of the container of cool water, the refrigerant has lost some of its energy and cooled. In order for the condenser to function correctly, the fluid passing through the fins of the condenser (usually, air) must be cooler than the working fluid of the system (Freon).

The purpose of the expansion device in a vapor compression refrigeration cycle is to control the flow of refrigerant to the evaporator. As the refrigerant leaves the condenser, it has cooled and condensed to liquid, but is still under high pressure. In order for the liquid to absorb the necessary heat in the evaporator, its pressure must be reduced, which is accomplished within the expansion device. The refrigerated centrifuge uses a capillary tube to accomplish this. Capillary tubes are lengths of tubing with a small inside diameter, which regulate fluid control through careful control of length and diameter. When compared with other expansion devices, the use of capillary tubes allows for less refrigerant in the system, as well as the elimination of the need for additional components such as sight glasses or receivers.

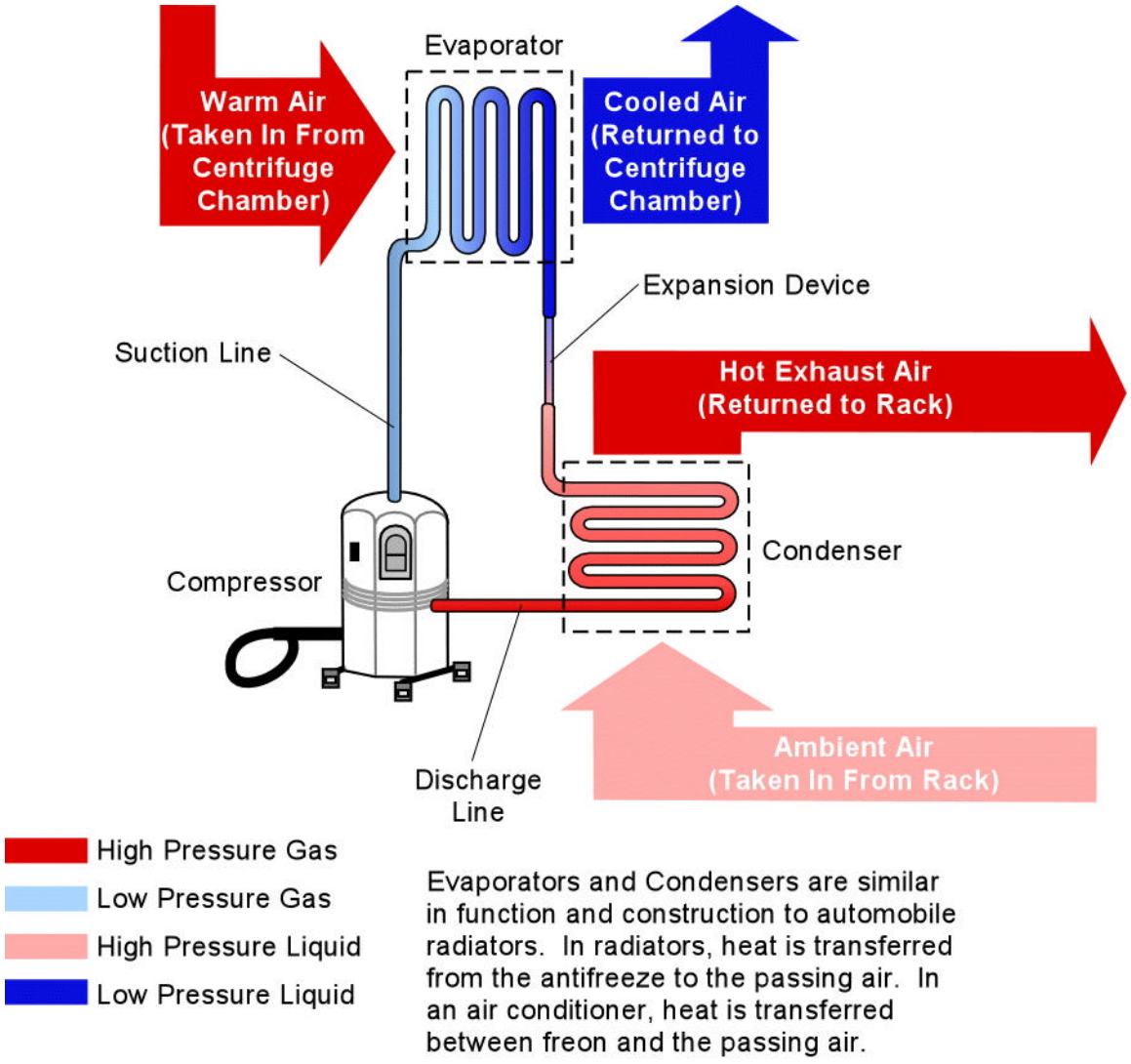


Figure 3.1.1.1-1. Vapor Compression Cycle

The evaporator is the component of the cycle that actually absorbs the heat from the conditioned space. The evaporator is similar in construction to the condenser, but its function is opposite. Thinking back to the container of water that was left outside on a hot summer afternoon, imagine that the container sits in the sun and has warmed. As the water continues to warm, it evaporates, leaves the container, and becomes vapor. This is the same process that happens to the refrigerant inside the evaporator. As the fluid leaves the expansion device, it is a cool liquid. As it passes through the evaporator, it picks up heat from the room and evaporates into a gaseous form. This evaporation is what enables the refrigerant to absorb the heat energy from the room.

As the refrigerant leaves the evaporator, it is returned to the cooled, low pressure state and is sent back to the compressor to begin the cycle again. Under normal circumstances the refrigerant will not wear out; it will be reused again and again, changing its physical form, but not its chemical composition.

The refrigerant is the fluid present in the vapor compression refrigeration cycle used to absorb heat in the evaporator and release heat in the condenser. The refrigerant is used again and again, cycle after cycle, but does not wear out under normal operating circumstances. The refrigerated centrifuge uses R404a as its working fluid. R404a is environmentally friendly, has been given a toxicity of 0, and is safe to use.

3.1.1.2 Rotor Assembly

There are three rotors that are being provided as part of the refrigerated centrifuge system. Each rotor has adapters that allow the user to size tube holder diameter down to the vial size diameter. The table below is a description of each rotor and specific adapters.

Rotor Capacity	**7 - 50 ml**	**2 - 10 ml**	**.4 - 2.2 ml**
Adapters	12 and 7 ml	5 ml	1.5 and .5 ml
Max speed	6000 RPM	5000 RPM	14,000 RPM

3.1.2 Design Approach

The HRF RC will be a Commercial-Off-the-Shelf (COTS) unit that will be modified to meet flight requirements. Modifications currently identified are:

1. Modify or replace the compressor with a non-gravity dependent compressor.
2. Modify power and/or compressor motor to make it compatible with Direct Current (DC) power.
3. Conformal coat the Printed Circuit Boards.
4. Develop a mounting mechanism to reconfigure to fit in a 12 PU drawer.
5. Repackage internal components.

6. Add vibration isolation to reduce micro-gravity disturbances to the rack.
7. Add labels.
8. Add sensors to monitor hardware temperature, pressure, and current parameters.

3.1.3 Operations

During launch and landing, the RC will be rack mounted in a 12 PU active drawer. During on-orbit operations, the RC shall be rack mounted in an HRF Rack 12 PU active drawer.

The RC will be used to separate biological samples such as blood and saliva. The front panel of the 12 PU drawer will open to expose the centrifuge rotor. The crewmember will select a rotor as identified in the experiment protocol procedures. The rotor is removed and replaced with the use of an Allen wrench that is provided as a part of the centrifuge system. The Station provided tool kit will also include an Allen wrench that could be used for this purpose. The samples will be loaded, and the door will be closed. The controls will be set for the appropriate time, temperature, rotor speed, and ramp up and down speeds.

If an imbalance is detected during the centrifugation, the rotor will automatically stop spinning. Emergency stop capability also allows the user to stop the rotor from spinning. For both the imbalance and emergency stop features, the rotor will brake at the maximum braking speed.

3.2 CHARACTERISTICS

3.2.1 Performance Characteristics

Performance characteristics are derived from the Functional Requirements Document (FRD) LS-71001.

3.2.1.1 Functional Performance Characteristics

3.2.1.1.1 Centrifugation

The refrigerated centrifuge shall provide a system for separation of biological samples based on differing sample densities.

3.2.1.1.2 Timed Centrifugation

A. The centrifuge shall be capable of running from 1 to 30 minutes.

B. The run time shall be selectable in one-minute increments.

C. There shall be a hold feature to allow for indefinite run times.

3.2.1.1.3 Programmable Force

The selectable speed is based on rotor selection.

A. The RC shall provide selectable speed over a minimum range of 1000 to 5000 RPM.

B. At minimum the speed shall be selectable in increments of 100 RPM.

3.2.1.1.4 Sample Sizes

A. The centrifuge shall accommodate sample sizes from .5 to 50 ml.

B. The centrifuge shall accommodate a minimum of 6 of the 50 ml vials at a time.

3.2.1.1.5 Programmable Protocols

The RC shall provide programmable centrifugation protocols that may be overridden if necessary.

3.2.1.1.6 Visual Alert

The RC shall provide a visual alert when centrifuge protocol has ended.

3.2.1.1.7 Emergency Stop

The RC shall provide an emergency stop capability that will stop the rotor (brake) from spinning.

3.2.1.1.8 Unbalanced Conditions

The RC shall provide the capability to detect unbalanced conditions during centrifugation and automatically shut down the centrifuge.

3.2.1.1.9 Refrigeration

A. RC shall provide refrigeration of the rotor chamber from ambient to +4 °C. Percent error is +2 °C or -4 °C.

B. The temperature set points shall be selectable in increments of 2 °C.

3.2.1.1.10 Controlled Angular (Spin-up) Acceleration/Deceleration (Braking)

The RC shall be capable of manually controlled (or equivalent) rotor angular acceleration and deceleration (braking).

3.2.1.1.11 Displays

A. The temperature of the rotor chamber shall be displayed continuously while in use.

B. The rotor speed shall be displayed continuously while in use.

3.2.1.1.12 Data Monitoring

The RC will provide an independent monitoring system to interface with the RIC located in the rack. The data will be used by ground personnel only and will not be accessible to the crew. The following parameters shall be monitored at a rate of once per minute while the hardware is operating.

3.2.1.1.12.1 Freon Pressures

A. The RC shall monitor high and low freon pressures.

B. The RC shall shut off at an over pressure of 450 psia.

3.2.1.1.12.2 Evaporator Temperature

The RC shall monitor the evaporator temperature. The output will be in ºC.

3.2.1.1.12.3 Chamber Temperature

The RC shall monitor the chamber temperature. The output will be in ºC.

3.2.1.1.12.4 Drawer Temperature

The RC shall monitor the internal drawer temperature. The output will be in ºC.

3.2.1.1.12.5 Motor Temperature

The RC shall monitor motor temperature. The output will be in ºC.

3.2.1.1.12.6 Input Current

The RC shall monitor the current distributed to the compressor.

3.2.2 Physical Characteristics

3.2.2.1 Mass Properties

The weight (mass) of the RC and all drawer components shall not exceed 64 pounds per set of slide guides, or a total of 192 pounds (58.06 kg).

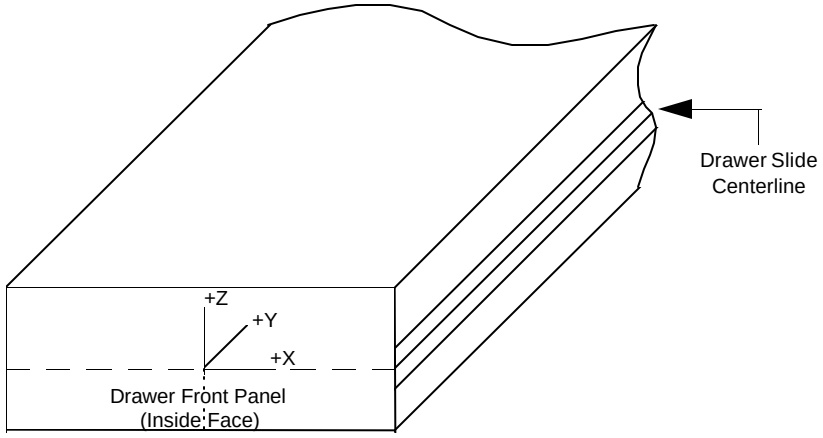
3.2.2.1.1 Human Research Facility Rack Mounted Standard Interface Rack Drawer Center-of-Gravity Constraints

The RC shall meet the 12 PU center of gravity constraints specified in Table 3.2.2.1.1-1, HRF SIR Drawer Center of Gravity Constraints. (LS-71000, Section 6.2.1.2.4)

TABLE 3.2.2.1.1-1. HRF SIR DRAWER CENTER OF GRAVITY CONSTRAINTS

DRAWER CONFIGURATION	X (in) MIN.	X (in) MAX.	Y (in) MIN.	Y (in) MAX.	Z (in) MIN.	Z (in) MAX.
Triple Slide Drawer (12 PU)	-1.50	+1.50	+9.74	+13.00	+6.37	+8.87

NOTE: Center-of-gravity envelope is measured from the drawer coordinate system as defined below. The geometric center for "Z" axis is measured from the centerline of the bottom-most rail toward the top of the drawer. Total maximum integrated mass (including drawer, contents and slides) on any one set of slides is limited to 64 pounds. Multiple-slide drawers are to evenly distribute loading between the sets of slides.



3.2.2.2 Envelope

3.2.2.2.1 Stowed Envelope

3.2.2.2.2 Deployed Envelope

3.2.2.2.2.1 On-Orbit Payload Protrusions

Definitions for on-orbit permanent protrusions, on-orbit semi-permanent protrusions, on-orbit temporary protrusions, on-orbit momentary protrusions, and protrusions for on-orbit keep alive payloads can be found in Section 6.1, Definitions. The requirements in Section 3.2.2.2.2.1 apply to installation and operation activities, but not to maintenance activities.

A. The RC shall not extend laterally across the edges of the rack or pass between racks. (LS-71000, Section 6.2.1.1.5.A)

B. Refrigerated Centrifuge, excluding momentary protrusions, shall not prevent attachment of Rack Mounting Adapter (RMA) on any seat track attach holes. (LS-71000, Section 6.2.1.1.5.B)

Constraints which may be associated with payload protrusions include:

- removal of the protrusion during rack installation, translation, and crew translation
- removal of the protrusion if the RMA is installed on the rack
- removal of the protrusion to prevent interference with microgravity operations
- removal or powering off of the rack if the protrusion blocks Portable Fire Extinguisher (PFE) access or the fire indicator
- may limit the rack location (e.g., protrusions located in the floor and the ceiling are limited to a total of no more than 12 inches.)
- may limit operation of the payload

As is indicated by the constraints above, protrusions have a negative impact on crew operations and are to be minimized.

3.2.2.2.2.1.1 On-Orbit Permanent Protrusions

The RC shall not allow permanent protrusions. (LS-71000, Section 6.2.1.1.5.1)

3.2.2.2.2.1.2 On-Orbit Semi-Permanent Protrusions

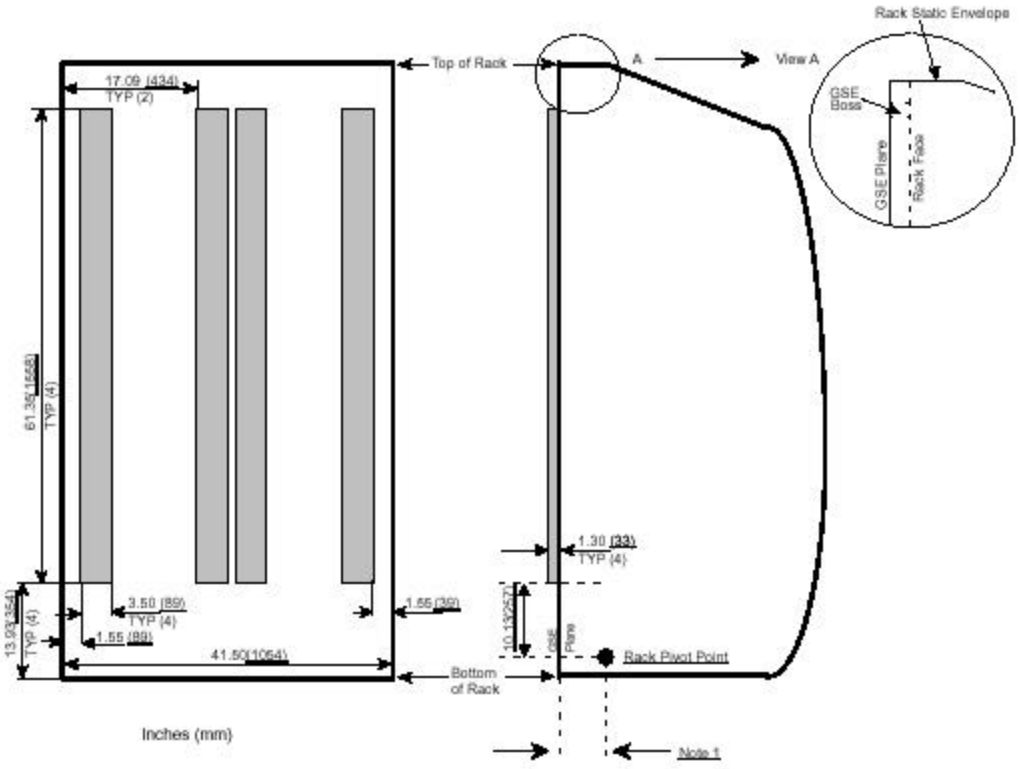
A. Standard Interface Rack (SIR) and International Subrack Interface Standard (ISIS) drawer handles shall remain within the envelope shown in Figure 3.2.2.2.2.1.2-1. (LS-71000, Section 6.2.1.1.5.2.A)

B. Other on–orbit semi–permanent protrusions shall be limited to no more than 500 square inches within the envelope shown in Figure 3.2.2.2.2.1.2–2. (LS-71000, Section 6.2.1.1.5.2.B)

C. All on-orbit semi-permanent protrusions shall be designed to be removable by the crew with hand operations and/or standard Intravehicular Activity (IVA) tools. (LS-71000, Section 6.2.1.1.5.2.C)

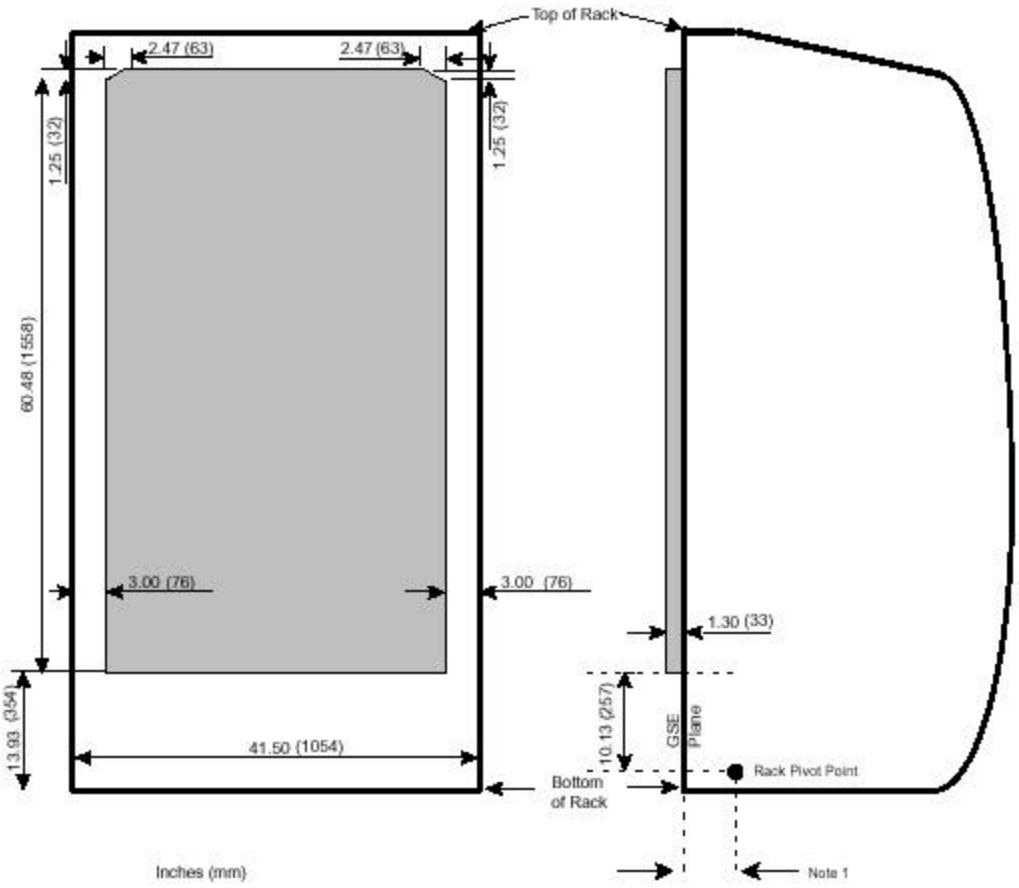
3.2.2.2.2.1.3 On-Orbit Temporary Protrusions

The RC does not have temporary protrusions.



Note:
1. The dimension for a Boeing ISPR is 3.50 (89). The dimension for a NASDA ISPR is 2.47 (63).

Figure 3.2.2.2.2.1.2-1. SIR and ISIS Drawer Handles Protrusion Envelope



Note:
1. The dimension for a Boeing ISPR is 3.50 (89). The dimension for a NASDA ISPR is 2.47 (63).
2. Protrusions are limited to 1.3 (33mm) inches for ground processing and launch/landing as described in paragraph 3.1.1.1.A

Figure 3.2.2.2.2.1.2-2. On-Orbit Semi-Permanent Protrusions Envelope

3.2.2.2.2.1.4 On-Orbit Momentary Protrusions

On-orbit momentary protrusions shall be designed such that they can be eliminated within 30 seconds. (LS-71000, Section 6.2.1.1.5.4)

The centrifuge chamber door and the stowage drawer are the only momentary protrusions contained within the RC.

3.2.2.2.2.2 Deployed Envelope Dimensions

3.2.3 Reliability, Quality, and Non-Conformance Reporting

A. Reliability and maintainability requirements for the HRF RC shall be as defined in LS-71026, "Human Research Facility (HRF) Reliability Plan." (LS-71000, Section 7.1.2)

B. Quality Assurance for the HRF RC shall be implemented in accordance with the JPD 5335.1, "JSC Quality Manual."

C. Non-Conformance Reporting

1. For flight hardware produced under a contract or subcontract at a site other than Johnson Space Center (JSC), non-conformance reporting requirements shall be specified in the Statement of Work (SOW) Data Requirements List, and Definition Requirement Documents (DRDs) shall be used to identify the submittal and data requirements. (LS-71000, Section 7.3.2.1)

2. For flight hardware developed at JSC, non-conformance reporting shall be in accordance with JPD 5335.1 and the applicable technical division plan. (LS-71000, Section 7.3.2.2)

3. Non-conformances that meet the Level 1 Problem Reporting and Corrective Action criteria for payloads as defined in SSP 30223 shall be reported in accordance with SSP 30223. (LS-71000, Section 7.3.2.3)

4. Software non-conformance reporting shall be in accordance with LS-71020-1, "Software Development Plan for the Human Research Facility." (LS-71000, Section 7.3.2.4)

3.2.3.1 Failure Propagation

The design shall preclude propagation of failures from the payload to the environment outside the payload. (NSTS 1700.7B, Section 206)

3.2.3.2 Useful Life

HRF RC hardware shall be designed for a 10 year utilization. (LS-71000, Section 7.2.1)

3.2.4 Maintainability

A. Payload provided unique tools shall meet the requirements of SSP 50005, paragraph 11.2.3. (LS-71000, Section 6.4.4.2.6.3)

B. Not applicable to the RC (LS-71000, Section 6.4.4.3.1)

C. It shall be possible to mate/demate individual connectors without having to remove or mate/demate connectors on other ORUs or payloads during maintenance operations. (LS-71000, Section 6.4.4.3.2B)

D. Electrical connectors and cable installations shall permit disconnection and reconnection without damage to wiring connectors. (LS-71000, Section 6.4.4.3.2C)

E. Access to inspect or replace a hardware item (e.g., an ORU) which is planned to be accessed on a daily or weekly basis shall not require removal of another hardware item or more than one access cover. (LS-71000, Section 6.4.4.2.6)

F. Not applicable to the RC. Experiments are required to provide their own level of controls. (LS-71000, Section 6.4.3.1.2A)

G. Not applicable to the RC. (LS-71000, Section 6.4.3.1.2B)

H. ORUs shall be designed to be replaceable without requiring the removal of other components or assemblies.

3.2.4.1 Logistics and Maintenance

3.2.4.1.1 Payload In-Flight Maintenance

Payloads shall be designed to be maintainable using Space Station provided on-board tools. Available tools on-orbit are defined in the Payloads Accommodations Handbook, SSP 57020. (LS-71000, Section 6.4.10)

3.2.4.1.2 Maintenance

The centrifuge chamber will be wiped down after each spin with a Station provided disinfectant wipe. Any spills will be cleaned up in accordance with the experiment protocol. The crew will also need to swab up any condensation that was formed in the chamber with Station provided dry wipes.

The o-ring around the rotor chamber will be checked for damage periodically and replaced when necessary. This maintenance task requires no tools. At present, there is no way to calibrate the centrifuge. The drift of the rotor motor may be measured on-orbit, but there is no way to correct this drift.

The fan inlet filters will be designed so that they are accessible for cleaning.

3.2.5 Environmental Conditions

3.2.5.1 On-Orbit Environmental Conditions

3.2.5.1.1 On-Orbit Internal Environments

3.2.5.1.1.1 Pressure

The RC shall be safe when exposed to pressures of 0 to 104.8 kPa (0 to 15.2 psia). (LS-71000, Section 6.2.9.1.1)

3.2.5.1.1.2 Temperature

A. Operating temperature of the RC shall be 18º to 30ºC (65-85ºF).

B. The RC shall be safe when exposed to temperatures of 10 to 46 °C (50 to 115 °F). (LS-71000, Section 6.2.9.1.2)

3.2.5.1.1.3 Humidity

The RC request an exception to this requirement.

The Refrigerated Centrifuge shall be designed to not cause condensation when exposed to the ISS atmosphere ranging in dewpoint from 4.4 to 15 °C (40 to 60 °F) and in relative humidity from 25 to 75% except when condensation is an intended operation of the Refrigerated Centrifuge. For reference, Figure 3.2.5.1.1.3-1 depicts the temperature/humidity envelope defined by these dewpoint and relative humidity ranges for air (21% oxygen, 79% nitrogen) at one atmosphere pressure (14.7 psia). (LS-71000, Section 6.2.9.1.3)

NOTE: Condensation will form on the internal surfaces of the rotor chamber. See Section 3.2.4.1.2 for maintenance procedures.

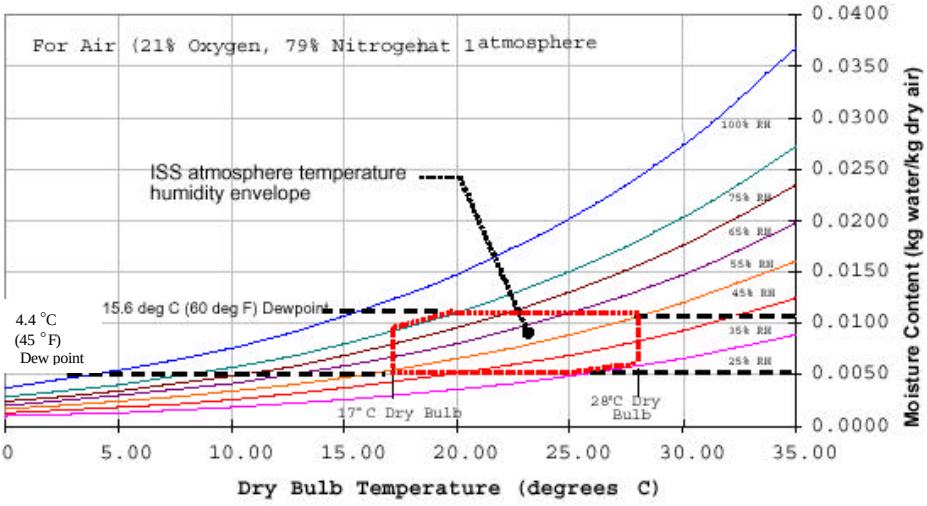


Figure 3.2.5.1.1.3-1. ISS Temperature/Humidity Envelope

3.2.5.1.2 Use of Cabin Atmosphere

3.2.5.1.2.1 Active Air Exchange

Not applicable

3.2.5.1.2.2 Oxygen Consumption

Not applicable to Refrigerated Centrifuge. (LS-71000, Section 6.2.9.2.2)

3.2.5.1.2.3 Chemical Releases

Chemical releases to the cabin air shall be in accordance with paragraphs 209.1a and 209.1b in NSTS 1700.7, ISS Addendum. (LS-71000, Section 6.2.9.2.3)

3.2.5.1.2.4 Cabin Air Heat Leak

Not applicable

3.2.5.1.3 Ionizing Radiation Requirements

3.2.5.1.3.1 Instrument Contained or Generated Ionizing Radiation

Not applicable to the RC. The RC does not generate ionizing radiation. (LS-71000, Section 6.2.9.3.1)

3.2.5.1.3.2 Ionizing Radiation Dose

NOTE: This is a testing guideline and is not a verifiable requirement.

Instruments should expect a total dose (including trapped protons and electrons) of 30 Rads (Si) per year of ionizing radiation. A review of the dose estimates in the ISS (SAIC-TN-9550) may show ionizing radiation exposure to be different than 30 Rads (Si) per year, if the intended location of the rack in the ISS is known. (LS-71000, Section 6.2.9.3.2)

3.2.5.1.3.3 Single Event Effect (SEE) Ionizing Radiation

The RC shall be designed so as not to produce an unsafe condition or one that could cause damage to equipment external to the RC as a result of exposure to SEE ionizing radiation, assuming exposure levels specified in SSP 30512, paragraph 3.2.1, with a shielding thickness of 25.4 mm (1000 mils). (LS-71000, Section 6.2.9.3.3)

3.2.5.1.4 Additional Environmental Conditions

The environmental information provided in Table 6.2.9.3-1, Environmental Conditions on ISS, and Figure 6.2.9.3-1, Operating Limits of the ISS Atmospheric Total Pressure, Nitrogen and Oxygen Partial Pressures, in LS-71000, is supplied for design and analysis purposes. (LS-71000, Section 6.2.9.4)

3.2.5.1.5 Pressure Rate of Change

A. The RC shall maintain positive margins of safety for the on-orbit depress/repress rates in Table 3.2.5.1.5-1. (LS-71000, Section 6.2.1.1.6B)

TABLE 3.2.5.1.5-1. ISS PRESSURE RATE OF CHANGE

Depressurization	878 Pa/sec (7.64 psi/minute)
Repressurization	230 Pa/sec (2.0 psi/minute)

B. The RC shall maintain positive margins of safety for maximum depressurization and repressurization rates for the carrier(s) in which it will be transported. (LS-71000, Section 6.2.1.1.6B)

(1) The RC shall maintain positive margins of safety for maximum depressurization and repressurization rates for the Mini Pressurized Logistics Module (MPLM) documented in Table 3.2.5.1.5-2. (Derived from LS-71000, Section 6.2.1.1.6A)

TABLE 3.2.5.1.5-2. MPLM PRESSURE RATE OF CHANGE

Depressurization	890 Pa/sec (7.75 psi/minute)
Repressurization	800 Pa/sec (6.96 psi/minute)

C. Not applicable. The RC will be launched in an EXpedite the PRocessing of Experiments to Space Station (EXPRESS) rack in MPLM. (LS-71000, Section 6.2.1.1.6C)

D. Rack Dependent Instruments shall not have a pressure relief device on their front face. (LS-71000, Section 6.2.1.1.6D)

3.2.5.1.6 Microgravity

Not applicable.

NOTE: This requirement is under review and will be applied when the requirement is approved.

3.2.5.2 Acoustic Emission Limits

3.2.5.2.1 Continuous Noise Limits

Not applicable. The RC does not generate continuous noise.

3.2.5.2.2 Intermittent Noise Limits

A. The RC shall not exceed the Total Rack A-weighted Sound Pressure Level (SPL) Limit of 65 dBA. This SPL is derived from Table 3.2.5.2.2-1 in LS-71000, based on an estimated 1 hours maximum usage time within a 24 hour period. (LS-71000, Section 6.4.3.3.2A)

B. Not applicable. This is an integrated rack requirement. (LS-71000, Section 6.4.3.3.2B)

3.2.5.3 Lighting Design

Not applicable to Refrigerated Centrifuge.

3.2.5.4 Front Panel Surface Temperature

The RC shall be designed such that the average front surface temperature is less than 37° C (98.6° F) with a maximum temperature limit not to exceed 49° C (120° F). (LS-71000, Section 6.2.5.3)

3.2.6 Transportability

3.2.6.1 Launch and Landing

Not applicable.

3.2.7 Operational Interface Requirements

3.2.7.1 Mechanical Interface Requirements

3.2.7.1.1 Connector Physical Mate

Not applicable to RC.

3.2.7.1.2 Human Research Facility Rack to Standard Interface Rack Drawer Structural Interface Requirements

3.2.7.1.2.1 Dimensional Tolerances

The RC dimensional tolerances shall be in accordance with Table 3.2.7.1.2.1-1. (LS-71000, Section 6.2.1.2.1)

TABLE 3.2.7.1.2.1-1. DIMENSIONAL TOLERANCES

English Dimension	Tolerance
X.XX	±0.030
X.XXX	±0.010
Xº	±1º

3.2.7.1.2.2 Standard Interface Rack Drawer Structural/ Mechanical Interfaces

The RC drawer shall meet the structural/mechanical interfaces as defined in LS-60077, Standard Interface Rack Specification.

3.2.7.2 Electrical Power Interface Requirements

Electrical requirements in this section are defined for instrument interfaces to the HRF rack 28 volt power outputs at HRF rack connector bars and rack connector panel. For the purposes of this section, compatibility means to remain safe and to provide operational functions within the range of accuracy specified for the instrument. (LS-71000, Section 6.2.2)

3.2.7.2.1 Human Research Facility Rack Power Output Connectors

3.2.7.2.1.1 Standard Interface Rack Drawer Power Connectors

SIR drawer instruments that receive electrical power from HRF rack connector bar interfaces shall connect to and be compatible with blind mate connector part number M83733/2RA018 with pin assignments as shown Figure 3.2.7.2.1.1-1 and Table 3.2.7.2.1.1-1. (LS-71000, Section 6.2.2.1.1)

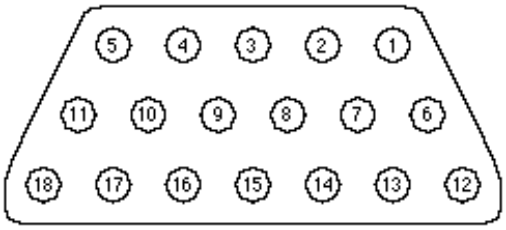


Figure 3.2.7.2.1.1-1. SIR Drawer Power Connector P/N: M83733/2RA018

TABLE 3.2.7.2.1.1-1. SIR DRAWER POWER CONNECTOR PIN ASSIGNMENTS

Pin	Type	Function	Note
1	Core	+28 Vdc Supply	0 to 20 Amperes
2	Core	+28 Vdc Return	
12	Core	Chassis Ground	

3.2.7.2.1.2 Rack Connector Panel J1 Power Connector

Not applicable. (LS-71000, Section 6.2.2.1.2)

3.2.7.2.2 Voltage Characteristics

3.2.7.2.2.1 Steady-State Operating Voltage Envelope

The RC shall be compatible with steady-state voltages within the range of +25.5 volts to + 29.5 volts. (LS-71000, Section 6.2.2.2.1)

3.2.7.2.2.2 Transient Operating Voltage Envelope

The RC shall be compatible with transient voltages within the range of +23.5 volts to + 30.5 volts for 60 ms. (LS-71000, Section 6.2.2.2.2)

3.2.7.2.2.3 Ripple Voltage/Noise Characteristics

A. The RC shall be compatible with a 1 volt peak-to-peak ripple in supply voltages within the ranges specified for steady state and transient voltage envelopes. (LS-71000, Section 6.2.2.2.3A)

B. The RC shall be compatible with the ripple voltage spectrum shown in Figure 3.2.7.2.2.3-1. (LS-71000, Section 6.2.2.2.3B)

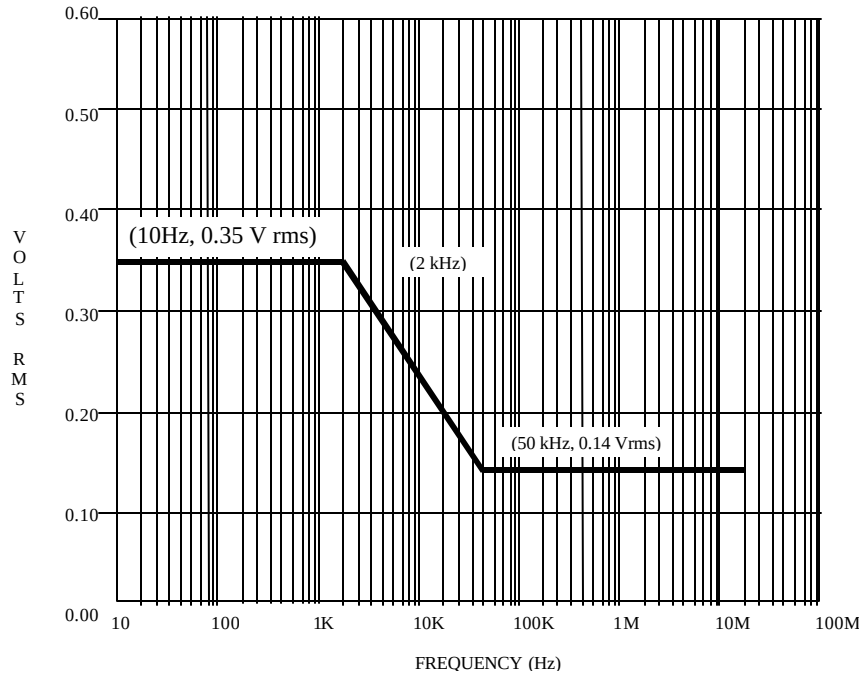
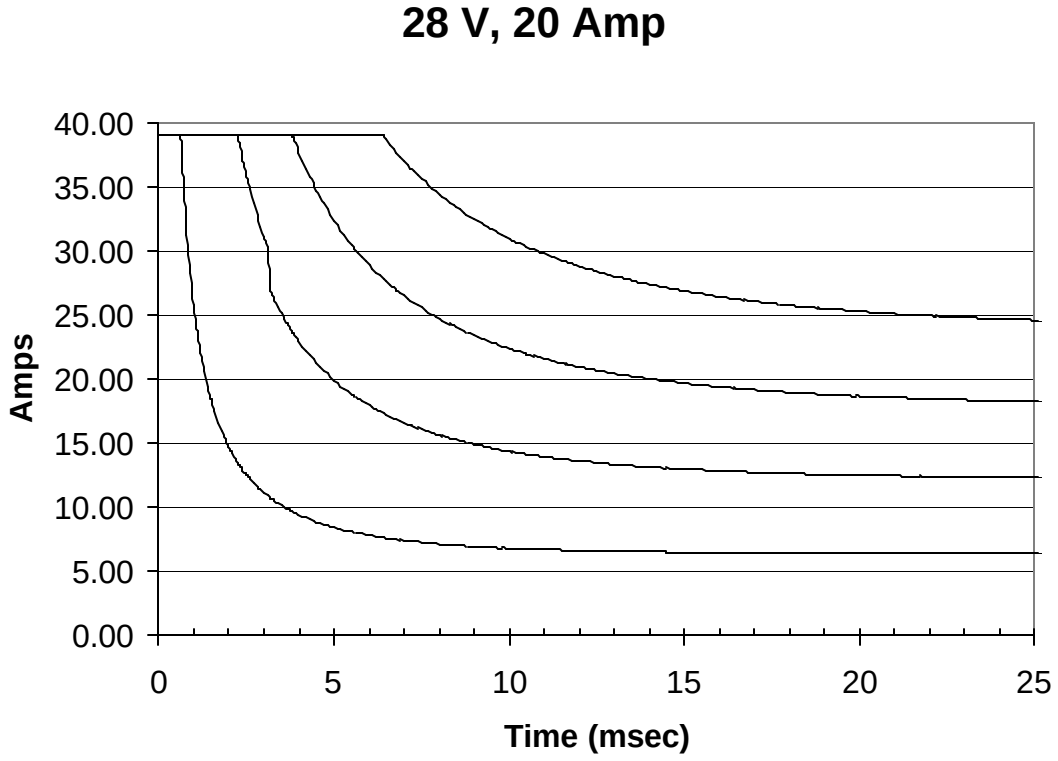


Figure 3.2.7.2.2.3-1. HRF Rack Power Output Ripple Voltage Spectrum

3.2.7.2.3 Maximum Current Limit

HRF rack dependent instruments shall be compatible with the maximum current provided for the selected current rating (5A, 10A, 15A, 20A) shown in Figure 3.2.7.2.3-1. (LS-71000, Section 6.2.2.3)



NOTES:

1) Current limit region shown above is defined for a capacitor load charge. In a direct short condition the actual trip time is 1/2 of the values shown.
2) For a progressive short in which the change in current has a slow rise time, an absolute maximum current limit of 2.5 times the normal current limit is provided. The time to trip for this condition is dictated by the I^2 x t trip limit.
3) Final current limit is obtained with in 100 μsecs and the initial current limit is a maximum of 2 times the final.
4) The current limit is 39.0A +/-20%.
5) The trip values for the long-duration portion of the trip curves are a nominal 120% of range.

Figure 3.2.7.2.3-1. HRF Rack Power Output Trip Curves

3.2.7.2.4 Reverse Current

HRF rack dependent instrument reverse current shall not exceed the following values at each 28 V power interface:

(1) 600A pulse with a duration less than 10 μs.

(2) 450A peak with a duration less than 1 ms.

(3) 2A continuous.

(LS-71000, Section 6.2.2.4)

3.2.7.2.5 Reverse Energy

The RC reverse energy shall not exceed 4 Joules at HRF rack 28 V power interfaces. (LS-71000, Section 6.2.2.5)

3.2.7.2.6 Capacitive Loads

The RC capacitive loads shall not exceed 50 microFarad per Ampere of rated output current at SIR drawer and rack connector panel power interfaces. (LS-71000, Section 6.2.2.6)

3.2.7.2.7 Electromagnetic Compatibility (EMC)

The RC shall meet the payload provider applicable requirements of SSP 30243, paragraphs 3.12 and 3.6.2. (LS-71000, Section 6.2.2.8)

3.2.7.2.7.1 Electrical Grounding

The RC shall meet all requirements specified in Section 3 of SSP 30240. (LS-71000, Section 6.2.2.8.1)

3.2.7.2.7.2 Electrical Bonding

Electrical bonding of the RC shall be in accordance with Class R and Class S SSP 30245 and NSTS 1700.7, ISS Addendum, Sections 213 and 220. (LS-71000, Section 6.2.2.8.2)

3.2.7.2.7.3 Electromagnetic Interference

A. The RC shall meet all Electromagnetic Interference (EMI) requirements of SSP 30237. (LS-71000, Section 6.2.2.8.4)

NOTE: The alternative use of RS03 stated below applies to radiated susceptibility requirements only. (LS-71000, Section 6.2.2.8.4)

B. Alternately, the payload Electrical Power Consuming Equipment (EPCE) may choose to accept a minimal increase of EMI risk with a somewhat less stringent Electric Field Radiated Susceptibility (RS03) requirement on equipment considered to be non-safety critical to the vehicle and crew. The tailored RS03 requirement, shown in Table 3.2.7.2.7.3-1 below, will hereafter be denoted RS03PL. (LS-71000, Section 6.2.2.8.4)

TABLE 3.2.7.2.7.3-1. RS03PL

FREQUENCY	RS03PL LIMIT (V/m)
14 kHz - 400 MHz	5
400 MHz - 450 MHz	30
450 MHz - 1 GHz	5
1 GHz - 5 GHz	25
5 GHz - 6 GHz	60
6 GHz - 10 GHz	20
13.7 GHz - 15.2 GHz	25

Comments:

1. The less stringent RS03PL limit was developed to envelope the electric fields generated by ISS transmitters and ground-based radars tasked to perform space surveillance and tracking. Ground-based radars that are not tasked to track the ISS and search radars that could momentarily sweep over the ISS are not enveloped by the relaxed RS03PL. For most scientific payloads, the minimal increase of EMI risk for the reduced limits is acceptable. The RS03PL limit does not account for module electric field shielding effectiveness that could theoretically reduce the limits even more. Although shielding effectiveness exists, it is highly dependent on the EPCE location within the module with respect to ISS windows.

2. The conducted susceptibility requirements CS01, CS02 and CS06 are also used as the local stability requirements in paragraph 3.2.2.10.

3.2.7.2.8 Electrostatic Discharge

Refrigerated Centrifuge will request an exception to the following requirements:

A. Unpowered Refrigerated Centrifuge EPCE shall not be damaged by Electrostatic Discharge (ESD) equal to or less than 4000 V to the case or any pin on external connectors. (LS-71000, Section 6.2.2.9)

B. Refrigerated Centrifuge EPCE that may be damaged by ESD between 4000 V and 15,000 V shall have a label affixed to the case in a location clearly visible in the installed position. (LS-71000, Section 6.2.2.9)

C. Labeling of Refrigerated Centrifuge EPCE susceptible to ESD up to 15,000 V shall be in accordance with MIL-STD-1686. (LS-71000, Section 6.2.2.9)

NOTE: These voltages are the result of charges that may be accumulated and discharged from ground personnel or crewmembers during equipment installation or removal. (LS-71000, Section 6.2.2.9)

3.2.7.2.9 Corona

The RC takes an exception to this requirement. The RC shall be designed to preclude damaging or destructive corona in its operating environment. Guidance for meeting the corona requirement is found in MSFC-STD-531, High Voltage Design Criteria. Per MIL-STD-531, corona is a luminous discharge due to the ionization of the gas surrounding a conductor around which exists a voltage gradient exceeding a certain critical value. (LS-71000, Section 6.2.2.12)

3.2.7.2.10 Cable/Wire Design and Control Requirements

Cabling shall meet all Cable and Wire requirements of SSP 30242. (LS-71000, Section 6.2.2.8.3)

3.2.7.2.10.1 Wire Derating

A. Circuit element derating criteria for the RC connected to HRF rack 28 volt power outlets shall be per National Aeronautics and Space Administration (NASA) Technical Memo (TM) 102179 as interpreted by NSTS 18798, TA-92-038. (LS-71000, Section 6.2.2.7.1A)

B. Circuit element derating shall be based on the maximum trip current for a 20 A Solid State Power Controller (SSPC) as specified in Figure 3.2.7.2.3-1. (LS-71000, Section 6.2.2.7.1B)

3.2.7.2.10.2 Exclusive Power Feeds

Not applicable. (LS-71000, Section 6.2.2.7.2)

3.2.7.2.11 Loss of Power

The RC shall fail safe in the event of a total or partial loss of power, regardless of the availability of auxiliary power in accordance with NSTS 1700.7, ISS Addendum. (LS-71000, Section 6.2.2.7.3)

3.2.7.2.12 Alternating Current Magnetic Fields

The generated Alternating Current (AC) magnetic fields, measured at a distance of 7 centimeters (cm) from the generating equipment, shall not exceed 140 dB above 1 picotesla for a frequency at 30 Hz, then falling 26.5 dB per decade to 3.5 kHz and 85 dB for frequencies ranging from 3.5 kHz to 50 kHz. (LS-71000, Section 6.2.2.10)

3.2.7.2.13 Direct Current Magnetic Fields

The generated DC magnetic fields shall not exceed 170 dB picotesla at a distance of 7 cm from the generating equipment. This applies to electromagnetic and permanent magnetic devices. (LS-71000, Section 6.2.2.11)

3.2.7.3 Command and Data Handling Interface Requirements

3.2.7.3.1 Human Research Facility Rack Data Connectors

3.2.7.3.1.1 Standard Interface Rack Drawer Data Connectors

The RC shall connect to blind mate connector part number M83733/2RA131, with pin assignments shown in Figure 3.2.7.3.1.1-1 and Table 3.2.7.3.1.1-1. (LS-71000, Section 6.2.3.1.1)

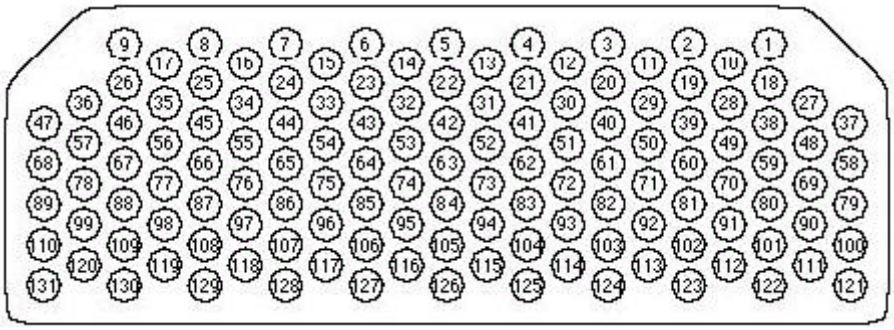


Figure 3.2.7.3.1.1-1. HRF SIR Drawer Data Connector P/N: M83733/2RA131

TABLE 3.2.7.3.1.1-1. HRF SIR DRAWER DATA CONNECTOR PIN ASSIGNMENTS

PIN	FUNCTION	AWG	SIGNAL NAME	COMMENTS
1	Reserved	#22	N/A	
2	Reserved	#22	N/A	
3	Spare	#22	N/A	
4	Discrete #1 (+)	#22	Discrete Signal 1	Bidirectional
5	Discrete #2 (+)	#22	Discrete Signal 2	Bidirectional
6	Reserved	#22	N/A	
7	Reserved	#22	N/A	
8	Reserved	#22	N/A	
9	Continuity Discrete (+)	#22	Discrete Signal	
10	Reserved	#22	N/A	
11	Spare	#22	N/A	
12	Spare	#22	N/A	
13	Discrete #1 (-)	#22	Discrete Return 1	Bidirectional
14	Discrete #2 (-)	#22	Discrete Return 2	Bidirectional
15	Reserved	#22	N/A	
16	Reserved	#22	N/A	
17	Reserved	#22	N/A	
18	Reserved	#22	N/A	
19	Reserved	#22	N/A	
20	Reserved	#22	N/A	
21	Spare	#22	N/A	
22	Spare	#22	N/A	
23	Spare	#22	N/A	
24	Analog #1 (+)	#22	Analog Signal 1	
25	Reserved	#22	N/A	
26	Reserved	#22	N/A	
27	Reserved	#22	N/A	
28	Reserved	#22	N/A	
29	Reserved	#22	N/A	
30	Reserved	#22	N/A	
31	Reserved	#22	N/A	
32	Reserved	#22	N/A	
33	Discrete Shield	#22	Shield	
34	Reserved	#22	N/A	
35	Reserved	#22	N/A	
36	Reserved	#22	N/A	
37	Reserved	#22	N/A	
38	Reserved	#22	N/A	
39	Reserved	#22	N/A	
40	Reserved	#22	N/A	
41	Reserved	#22	N/A	
42	Reserved	#22	N/A	
43	Reserved	#22	N/A	
44	Analog #1 (-)	#22	Analog Signal Return 1	
45	Reserved	#22	N/A	
46	Reserved	#22	N/A	
47	RS 170 (+)	#22	Video Signal	Video From Drawer
48	Reserved	#22	N/A	
49	Reserved	#22	N/A	
50	Reserved	#22	N/A	

TABLE 3.2.7.3.1.1-1. HRF SIR DRAWER DATA CONNECTOR PIN ASSIGNMENTS (Cont'd)

PIN	FUNCTION	AWG	SIGNAL NAME	COMMENTS
51	PPC B01 (+)	#22	Point-to-Point Signal 1	
52	Reserved	#22	N/A	
53	Spare	#22	N/A	
54	Spare	#22	N/A	
55	Analog #2 (-)	#22	Analog Signal Return 2	
56	Reserved	#22	N/A	
57	RS 170 Shield	#22	Video Shield	Video From Drawer
58	Reserved	#22	N/A	
59	Reserved	#22	N/A	
60	Reserved	#22	N/A	
61	PPC B01 (-)	#22	Point-to-Point Return 1	
62	PPC B02 (-)	#22	Point-to-Point Return 2	
63	Spare	#22	N/A	
64	Spare	#22	N/A	
65	Analog #2 (+)	#22	Analog Signal 2	
66	Reserved	#22	N/A	
67	RS 422 TX (+)	#22	RS422 Transmit Signal	RIC is reference
68	RS 170 (-)	#22	Video Return	Video From Drawer
69	Reserved	#22	N/A	
70	Reserved	#22	N/A	
71	PPC B01 Shield	#22	Point-to-Point Shield	
72	Reserved	#22	N/A	
73	PPC B02 Shield	#22	Point-to-Point Shield	
74	Spare	#22	N/A	
75	Analog Shield	#22	Shield	
76	Reserved	#22	N/A	
77	RS 422 TX Shield	#22	RS422 Transmit Shield	RIC is reference
78	RS 422 RX (+)	#22	RS422 Receive Signal	RIC is reference
79	Reserved	#22	N/A	
80	Reserved	#22	N/A	
81	Reserved	#22	N/A	
82	Reserved	#22	N/A	
83	PPC B02 (+)	#22	Point-to-Point Signal 2	
84	Spare	#22	N/A	
85	Spare	#22	N/A	
86	Spare	#22	N/A	
87	Reserved	#22	N/A	
88	RS 422 TX (-)	#22	RS422 Transmit Return	RIC is reference
89	RS 422 RX Shield	#22	Receive Shield	RIC is reference
90	Reserved	#22	N/A	
91	Reserved	#22	N/A	
92	PPC B03 Shield	#22	Shield	
93	PPC B03 (+)	#22	Point-to-Point Signal 3	
94	Reserved	#22	N/A	
95	Reserved	#22	N/A	
96	Spare	#22	N/A	
97	Reserved	#22	N/A	
98	Spare	#22	N/A	
99	RS 422 RX (-)	#22	RS422 Receive Return	RIC is reference

TABLE 3.2.7.3.1.1-1. HRF SIR DRAWER DATA CONNECTOR PIN ASSIGNMENTS (Cont'd)

PIN	FUNCTION	AWG	SIGNAL NAME	COMMENTS
100	Reserved	#22	N/A	
101	Reserved	#22	N/A	
102	Spare	#22	N/A	
103	PPC B03 (-)	#22	Point-to-Point Return 3	
104	Reserved	#22	N/A	
105	Ethernet RX (+)	#22	Receive Signal	P/L is reference
106	Reserved	#22	N/A	
107	Reserved	#22	N/A	
108	Reserved	#22	N/A	
109	Reserved	#22	N/A	
110	Reserved	#22	N/A	
111	Spare	#22	N/A	
112	Spare	#22	N/A	
113	PPC B04 (+)	#22	Point-to-Point Signal 4	
114	PPC B04 Shield	#22	Point-to-Point Shield	
115	Reserved	#22	N/A	
116	Ethernet RX (-)	#22	Receive Return	P/L is reference
117	Reserved	#22	N/A	
118	Ethernet TX Shield	#22	Transmit Shield	
119	Reserved	#22	N/A	
120	Reserved	#22	N/A	
121	Continuity Discrete (-)	#22	Signal	
122	Spare	#22	N/A	
123	Spare	#22	N/A	
124	PPC B04 (-)	#22	Point-to-Point Return 4	
125	Reserved	#22	N/A	
126	Ethernet RX Shield	#22	Receive Shield	
127	Reserved	#22	N/A	
128	Ethernet TX (+)	#22	Transmit Signal	P/L is reference
129	Ethernet TX (-)	#22	Transmit Return	P/L is reference
130	Reserved	#22	N/A	
131	Reserved	#22	N/A	

3.2.7.3.1.2 Human Research Facility Rack Connector Panel J2 Data Connector

Not applicable. (LS-71000, Section 6.2.3.1.2)

3.2.7.3.2 Human Research Facility Ethernet Interfaces

The RC shall meet American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE) 802.3 Standards. (LS-71000, Section 6.2.3.2)

3.2.7.3.3 Human Research Facility TIA/EIA-422 Interfaces

Not applicable. (LS-71000, Section 6.2.3.3)

3.2.7.3.4 Human Research Facility Bi-Directional Discretes Interfaces

Not applicable. (LS-71000, Section 6.2.3.4)

3.2.7.3.5 Human Research Facility Analog Interfaces

Rack dependent instruments that require differential analog interfaces at the rack connector panel or at SIR drawer connector bars shall be compatible with signal characteristics of -5 Vdc to +5 Vdc with a selectable sampling rate of 1, 10 or 100 Hz. (LS-71000, Section 6.2.3.5)

3.2.7.3.6 Flight Software Requirements

This section contains the software requirements for the Computer Software Configuration Items (CSCIs) associated with the HRF RC. Each software requirement will be traceable to a functional requirement in this HRD. The requirements traceability matrix is shown in Table 3.2.7.3.6-1. The verification process for each requirement is listed in the Functional Performance Verification Matrix (Appendix C). The type, category, and operational modes required shall be identified for each CSCI.

3.2.7.3.6.1 Definitions

Please refer to the Software Development Plan for the Human Research Facility (LS-71020) for definitions of the software type, software category, and configuration item terms.

3.2.7.3.6.2 Modes

The RC CSCI will have one mode. In this mode, data will be collected and transferred to the EXPRESS RIC as a health and status packet.

3.2.7.3.6.3 Human Research Facility Refrigerated Centrifuge Software

The HRF Refrigerated Centrifuge CSCI is custom-built flight software that allows centrifuge health and status data to be collected and transmitted to the ground through the EXPRESS RIC.

TABLE 3.2.7.3.6-1. SOFTWARE REQUIREMENT TRACEABILITY

HRD Hardware Requirement	HRD CSCI Requirement
3.2.1.1.12.1A	3.2.7.3.6.3.1A, 3.2.7.3.6.3.1B, 3.2.7.3.6.3.1C, 3.2.7.3.6.3.1D, 3.2.7.3.6.3.2.1, 3.2.7.3.6.3.2.2, 3.2.7.6.3.2.3, 3.2.7.3.6.3.8, 3.2.7.3.6.3.9A, 3.2.7.3.6.3.9B
3.2.1.12.1B	3.2.7.3.6.3.1A, 3.2.7.3.6.3.1B, 3.2.7.3.6.3.1C, 3.2.7.3.6.3.1D, 3.2.7.3.6.3.2.1, 3.2.7.3.6.3.2.2, 3.2.7.6.3.2.3, 3.2.7.3.6.3.8, 3.2.7.3.6.3.9A, 3.2.7.3.6.3.9B
3.2.1.1.12.2	3.2.7.3.6.3.1A, 3.2.7.3.6.3.1B, 3.2.7.3.6.3.1C, 3.2.7.3.6.3.1D, 3.2.7.3.6.3.2.1, 3.2.7.3.6.3.2.2, 3.2.7.6.3.2.3, 3.2.7.3.6.3.8, 3.2.7.3.6.3.9A, 3.2.7.3.6.3.9B
3.2.1.1.12.3	3.2.7.3.6.3.1A, 3.2.7.3.6.3.1B, 3.2.7.3.6.3.1C, 3.2.7.3.6.3.1D, 3.2.7.3.6.3.2.1, 3.2.7.3.6.3.2.2, 3.2.7.6.3.2.3, 3.2.7.3.6.3.8, 3.2.7.3.6.3.9A, 3.2.7.3.6.3.9B
3.2.1.1.12.4	3.2.7.3.6.3.1A, 3.2.7.3.6.3.1B, 3.2.7.3.6.3.1C, 3.2.7.3.6.3.1D, 3.2.7.3.6.3.2.1, 3.2.7.3.6.3.2.2, 3.2.7.6.3.2.3, 3.2.7.3.6.3.8, 3.2.7.3.6.3.9A, 3.2.7.3.6.3.9B
3.2.1.1.12.5	3.2.7.3.6.3.1A, 3.2.7.3.6.3.1B, 3.2.7.3.6.3.1C, 3.2.7.3.6.3.1D, 3.2.7.3.6.3.2.1, 3.2.7.3.6.3.2.2, 3.2.7.6.3.2.3, 3.2.7.3.6.3.8, 3.2.7.3.6.3.9A, 3.2.7.3.6.3.9B
3.2.1.1.12.6	3.2.7.3.6.3.1A, 3.2.7.3.6.3.1B, 3.2.7.3.6.3.1C, 3.2.7.3.6.3.1D, 3.2.7.3.6.3.2.1, 3.2.7.3.6.3.2.2, 3.2.7.6.3.2.3, 3.2.7.3.6.3.8, 3.2.7.3.6.3.9A, 3.2.7.3.6.3.9B

3.2.7.3.6.3.1 Computer Software Configuration Item Functional and Performance Requirements

A. The CSCI shall collect freon pressure, evaporator temperature, chamber temperature, box temperature, motor temperature, and current distributed to the compressor.

B. The CSCI shall place collected data in a health and status packet.

C. The CSCI shall transmit centrifuge system data to the RIC in a health and status data packet at a rate of 1 Hz.

D. The CSCI shall recollect the centrifuge system data at a minimum of once per minute.

E. The CSCI shall load initialization data from a configuration file on startup. Initialization data will be specified in the HRF Software Design Document, LS-71083.

3.2.7.3.6.3.2 Computer Software Configuration Item External Interface Requirements

Listed below are the external interface software requirements for the RC CSCI.

3.2.7.3.6.3.2.1 Word/Byte Notations, Types and Data Transmissions

3.2.7.3.6.3.2.1.1 Word/Byte Notations

HRF rack dependent instruments shall use the word/byte notations as specified in paragraph 3.1.1, Notations in SSP 52050. (LS-71000, Section 6.2.3.6.1)

3.2.7.3.6.3.2.1.2 Data Types

HRF rack dependent instruments shall use the data types as specified in paragraph 3.2.1 and subsections, Data Formats in SSP 52050. (LS-71000, Section 6.2.3.6.2)

3.2.7.3.6.3.2.1.3 International Space Station Command and Data Handling Services Through the HRF Rack Interface Controller

The HRF RC CSCI shall request services in accordance with D683-43631-1, EXPRESS Payload Software Interface Control Document - Human Research Facility. (LS-71000, Section 6.2.3.9)

3.2.7.3.6.3.3 Computer Software Configuration Item Internal Interface Requirements

The internal HRF RC CSCI interfaces will be defined in the HRF Software Design Document.

3.2.7.3.6.3.4 Computer Software Configuration Item Internal Data Requirements

The internal HRF RC CSCI data will be defined in the HRF Software Design Document.

3.2.7.3.6.3.5 Computer Software Configuration Item Adaptation Requirements

There are no CSCI adaptation requirements for the HRF RC CSCI.

3.2.7.3.6.3.6 Software Safety Requirements

The HRF RC CSCI shall not be used to hold, store, or process any safety critical parameters or commands.

3.2.7.3.6.3.7 Data Privacy Requirements

There are no CSCI data privacy requirements for the HRF RC CSCI.

3.2.7.3.6.3.8 Computer Software Configuration Item Environment Requirements

THE HRF RC CSCI shall execute on a single board computer or equivalent capable of up to 8 channels for data acquisition.

3.2.7.3.6.3.9 Software Quality Factors

A. The HRF RC CSCI shall generate repeatable results given the same initialization data. (LS-71000, Section 6.2.3.7C)

B. The HRF RC CSCI source code shall compile and build an executable image without producing any compiler or build errors.

3.2.7.3.6.3.10 Design and Implementation Constraints

The HRF RC CSCI will be developed in accordance with the HRF Coding Style Guide in Appendix C of the HRF Software Development Plan (LS-71020).

3.2.7.3.6.3.11 Precedence and Criticality of Requirements

All requirements specified in Section 3.2.7.3.6 are equally weighed.

3.2.7.3.6.4 Notes

None.

3.2.7.3.7 Reserved

3.2.7.3.8 Reserved

3.2.7.3.9 Reserved

3.2.7.3.10 Medium Rate Data Link

Not applicable to RC.

3.2.7.4 Payload National Television Standards Committee Video Interface Requirements

Not applicable to RC.

3.2.7.5 Thermal Control Interface Requirements

Not applicable to the RC.

3.2.7.5.1 Human Research Facility Rack Provided Internal Thermal Control System Moderate Temperatures Loop Interface

Not applicable.

3.2.7.5.2 Human Research Facility Rack Heat Exchanger to Standard Interface Rack Drawer Interface

Not applicable. This is an integrated rack requirement. (LS-71000, Section 6.2.5.2)

3.2.7.5.2.1 Heat Exchanger Interface Maximum Heat Load

The RC shall limit heat load into the heat exchanger to less than or equal to 500 Watts per heat exchanger. (LS-71000, Section 6.2.5.2.1)

3.2.7.5.2.2 Human Research Facility Rack Mounted Standard Interface Rack Drawer Cooling Fans

A. Fan Hardware

SIR drawer instruments mounted in HRF racks shall use a HRF common fan, part number SEG46116060-702, defined in NASA/JSC drawing SEG 46116060. (LS-71000, Section 6.2.5.2.2A)

B. Fan Location

The fan shall be located on the inside of the payload drawer in the rear right hand side (as viewed from the front of the rack). (LS-71000, Section 6.2.5.2.2B

C. Vibration Isolation

The fan shall be mounted with a Vibration Isolation Gasket between the fan and chassis. (LS-71000, Section 6.2.5.2.2C)

D. Fan Mounting

The fan mounting shall be such that the fan can be IVA replaceable. (LS-71000, Section 6.2.5.2.2D)

E. Fan Operating Voltage

Fans shall operate within a voltage range of 25.5 to 29.5 Vdc. (LS-71000, Section 6.2.5.2.2E)

F. Fan Speed Controller

The hardware developer shall control the common fan at the lowest speed required to provide sufficient cooling air (32 °C inlet air temperature) to the instrument. This speed shall be determined by thermal analysis and HRF Systems Engineering and Integration (SE&I). It is the hardware developer's responsibility for the design of a fan speed controller if one is deemed necessary. Reference NASA/JSC drawing SEG46117051 for an approved fan speed controller. (LS-71000, Section 6.2.5.2.2F)

NOTE: A fan-to-heat exchanger close-out gasket between the Payload Drawer and the Rack Connector bar will be provided by the rack integrator and installed onto the rack connector bar. (LS-71000, Section 6.2.5.2.2 Note)

3.2.7.6 Vacuum System Requirements

Not applicable to Refrigerated Centrifuge.

3.2.7.7 Pressurized Gas Interface Requirements

3.2.7.7.1 Nitrogen Interface Requirements

Not applicable to RC.

3.2.7.7.2 Pressurized Gas Systems

Not applicable. The RC contains ~4 liters of expanded gas volume. (LS-71000, Section 6.2.7.2)

3.2.7.7.3 Manual Valves

Not applicable to RC.

3.2.7.8 Payload Support Services Interfaces Requirements

Not applicable to RC.

3.2.7.9 Fire Protection Interface Requirements

NOTE: HRF dependent instruments that have forced air circulation and are mounted in SIR drawer locations within the HRF rack are monitored by the HRF rack smoke detector. The ISS PFE is capable of extinguishing fires within these instrument volumes when discharged into the HRF rack PFE access port. These instruments do not require additional smoke detectors or PFE access ports. (LS-71000, Section 6.2.10)

3.2.7.9.1 Fire Prevention

The RC shall meet the fire prevention requirements specified in NSTS 1700.7B, ISS Addendum, paragraph 220.10a. (LS-71000, Section 6.2.10.1)

NOTE: Reference in SSP 57000C and LS-71000A to paragraph 220.10a is a typographical error. The reference should be to paragraph 220.10.

3.2.7.9.2 Payload Monitoring and Detection Requirements

Not applicable to RC.

3.2.7.9.3 Fire Suppression

Not applicable to RC.

3.2.7.9.4 Labeling

Not applicable to RC.

3.2.7.10 Other Interface Requirements

Not applicable to RC.

3.3 DESIGN AND CONSTRUCTION

3.3.1 Materials, Processes, and Parts

3.3.1.1 Materials and Processes

3.3.1.1.1 Materials and Parts Use and Selection

The RC shall use materials and parts that meet the materials requirements specified in NSTS 1700.7B, ISS Addendum, Section 209. (LS-71000, Section 6.2.11.1)

3.3.1.1.2 Commercial Parts

COTS parts used in the RC shall meet the materials requirements specified in NSTS 1700.7B, ISS Addendum, Section 209. (LS-71000, Section 6.2.11.2)

3.3.1.1.3 Fluids

Not applicable to RC.

3.3.1.1.4 Cleanliness

The RC shall conform to Visibly Clean - Sensitive (VC-S) requirements as specified in SN-C-0005. (LS-71000, Section 6.2.11.4)

3.3.1.1.5 Fungus Resistant Material

The RC shall use fungus resistant materials according to the requirements specified in SSP 30233, paragraph 4.2.10. (LS-71000, Section 6.2.11.5)

3.3.1.2 Sharp Edges and Corner Protection

The RC design within a pressurized module shall protect crewmembers from sharp edges and corners during all crew operations in accordance with NSTS 1700.7, ISS Addendum, paragraph 222.1. (LS-71000, Section 6.4.9.2)

3.3.1.3 Holes

Holes that are round or slotted in the range of 10.0 to 25.0 mm (0.4 to 1.0 in) shall be covered. (LS-71000, Section 6.4.9.3)

3.3.1.4 Latches

Latches that pivot, retract, or flex so that a gap of less than 35 mm (1.4 in) exists shall be designed to prevent entrapment of a crewmember's appendage. (LS-71000, Section 6.4.9.4)

3.3.1.5 Screws and Bolts

Threaded ends of screws and bolts accessible by the crew and extending more than 3.0 mm (0.12 in) shall be capped to protect against sharp threads. (LS-71000, Section 6.4.9.5)

3.3.1.6 Securing Pins

Not applicable to RC.

3.3.1.7 Levers, Cranks, Hooks, and Controls

Levers, cranks, hooks, and controls shall not be located where they can pinch, snag, or cut the crewmembers or their clothing. (LS-71000, Section 6.4.9.7)

3.3.1.8 Burrs

Exposed surfaces shall be free of burrs. (LS-71000, Section 6.4.9.8)

3.3.1.9 Locking Wires

A. Safety wires shall not be used on fasteners which must be unfastened for on-orbit removal or replacement. (LS-71000, Section 6.4.9.9A)

B. All fracture-critical fasteners as defined in SSP 52005 (paragraph 5.6, Fastener Requirements, and Appendix B, Glossary of Terms), which must be unfastened for on-orbit removal or replacement, shall be safety cabled or cotterpinned. (LS-71000, Section 6.4.9.9B)

3.3.1.10 Fracture/Fatigue

The RC shall be designed to prevent the creation or propagation of any material failures per the requirements of LS-71010, "Fracture Control Plan for the Human Research Facility."

3.3.1.11 Threaded Locking Adhesive

Any liquid locking substance shall be applied per MIL-S-33540, "General Specification for Liquid Locking Compounds."

3.3.2 Nameplates and Product Marking

3.3.2.1 Equipment Identification

The refrigerated centrifuge, all accessories, Orbital Replacement Unit's (ORU's) crew-accessible connectors and cables, switches, indicators, and controls shall be labeled. Labels are markings of any form [including Inventory Management System (IMS) bar codes] such as decals and placards, which can be adhered, "silk screened," engraved, or otherwise applied directly onto the hardware. Appendix C of SSP 57000 provides instructions for label and decal design and approval. (LS-71000, Section 6.4.7)

3.3.3 Workmanship

Workmanship shall be in accordance with approved NASA and industry recognized standards.

3.3.4 Interchangeability

The RC will be built to flight released drawings. This will ensure interchangeability among each subassembly.

3.3.5 Safety Requirements

3.3.5.1 Electrical Safety

HRF rack dependent instruments shall meet the electrical safety requirements as defined in NSTS 1700.7B, ISS Addendum. (LS-71000, Section 6.2.2.14)

3.3.5.1.1 Safety-Critical Circuits Redundancy

Not applicable to RC.

3.3.5.1.2 Electromagnetic Interference Susceptibility for Safety-Critical Circuits

Not applicable to RC.

3.3.5.1.3 Mating/Demating of Powered Connectors

Not applicable. The RC does not have any connectors that require the crew mate/demate.

3.3.5.1.4 Power Switches/Controls

A. Switches/controls performing on/off power functions for all RC power interfaces shall open (dead-face) all supply circuit conductors except the power return and the equipment grounding conductor while in the power-off position. (LS-71000, Section 6.2.2.15A)

B. Power-off markings and/or indications shall be used only if all parts, with the exception of overcurrent devices and associated EMI filters, are disconnected from the supply circuit. (LS-71000, Section 6.2.2.15B)

C. Standby, charging, or other descriptive nomenclature shall be used to indicate that the supply circuit is not completely disconnected for this power condition. (LS-71000, Section 6.2.2.15C)

3.3.5.1.5 Ground Fault Circuit Interrupters (GFCIs)/Portable Equipment DC Sourcing Voltage

Not applicable to RC.

3.3.5.1.6 Portable Equipment/Power Cords

Not applicable to RC.

3.3.6 Human Engineering

3.3.6.1 Closures or Covers Design Requirements

Closures or covers shall be provided for any area of the payload that is not designed for routine cleaning. (LS-71000, Section 6.4.3.1.1)

3.3.6.2 Interior Color

3.3.6.2.1 Rack Mounted Equipment

A. SSP 50008, Rev. A, page 3-4, Table 3.2.7.1, applies to HRF rack mounted hardware. Front panels for active and stowage drawers meant for installation in HRF racks shall match off-white, specification #27722 as given in FED-STD-595B, "Federal Standard Colors Used in Government Procurement." (LS-71000, Section 6.4.3.5.1)

B. Not applicable.

C. SIR drawer panel handle latches are not subject to requirements 3.3.6.2.1 A and B and shall be finished in accordance with the engineering drawings for the panel handle latches. (LS-71000, Section 6.4.3.5.1)

3.3.6.2.2 Stowed/Deployable Equipment

The colors and finishes for stowed and deployable equipment, even if it is normally attached to the rack during use, shall be as specified below:

A. COTS equipment that is not repackaged by HRF engineers shall be finished as delivered by the manufacturer. (LS-71000, Section 6.4.3.5.2A)

B. Items that are repackaged by HRF engineers shall be finished using anodic film per MIL-A-8625, Type II, Class 2, Dyed Turquoise. Reference FED-STD-595, Color Specification 15187. (LS-71000, Section 6.4.3.5.2B)

3.3.6.2.3 Colors for Soft Goods

Not applicable. The RC does not contain soft goods. (LS-71000, Section 6.4.3.5.3)

3.3.6.3 Full Size Range Accommodation

All payload workstations and hardware having crew nominal operations and planned maintenance shall be sized to meet the functional reach limits for the 5th percentile Japanese female and yet shall not constrict or confine the body envelope for the 95th percentile American male as specified in SSP 50005, Section 3. (LS-71000, Section 6.4.2.3)

3.3.6.4 Operation and Control of Payload Equipment

A. Grip Strength

To remove, replace and operate payload hardware, grip strength required shall be less than 254 N (57 lbf). (LS-71000, Section 6.4.1.1A)

B. Linear Forces

Linear forces required to operate or control payload hardware or equipment shall be less than the strength values for the 5th percentile female, defined as 50% of the strength values shown in Figure 3.3.6.4-1 and 60% of the strength values shown in Figure 3.3.6.4-2. (LS-71000, Section 6.4.1.1B)

C. Torque

Torque required to operate or control payload hardware or equipment shall be less than the strength values for the 5th percentile female, defined as 60% of the calculated 5th percentile male capability shown in Figure 3.3.6.4-3. (LS-71000, Section 6.4.1.1C)

3.3.6.5 Maintenance Operations

Forces required for maintenance of payload hardware and equipment shall be less than the 5th percentile male strength values shown in Figures 3.3.6.4-1, 3.3.6.4-2, 3.3.6.4-3, 3.3.6.5-1, and 3.3.6.5-2. (LS-71000, Section 6.4.1.2)

3.3.6.6 Adequate Clearance

Not applicable to RC.

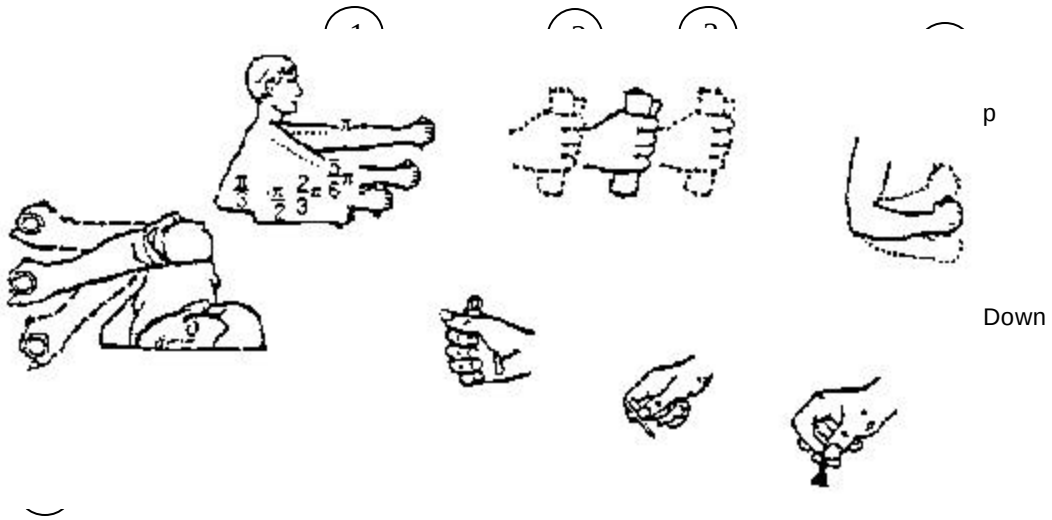
3.3.6.7 Accessibility

A. Payload hardware shall be geometrically arranged to provide physical and visual access for all payload installation, operations, and maintenance tasks. Payload ORUs should be removable along a straight path until they have cleared the surrounding structure. (LS-71000, Section 6.4.2.2A)

B. IVA clearances for finger access shall be provided as given in Figure 3.3.6.7-1. (LS-71000, Section 6.4.2.2B)

3.3.6.8 One-Handed Operation

Cleaning equipment and supplies shall be designed for one-handed operation or use. (LS-71000, Section 6.4.3.1.3)



Arm Strength (N)												
(1)	(2)		(3)		(4)		(5)		(6)		(7)	
Degree of elbow flexion (rad)	Pull		Push		Up		Down		In		Out	
	L**	R**	L	R	L	R	L	R	L	R	L	R
p	222	231	187	222	40	62	58	76	58	89	36	62
5/6 p	187	249	133	187	67	80	80	89	67	89	36	67
2/3 p	151	187	116	160	76	107	93	116	89	98	45	67
1/2 p	142	165	98	160	76	89	93	116	71	80	45	71
1/3 p	116	107	96	151	67	89	80	89	76	89	53	76
Hand and thumb-finger strength (N)												
	(8)				(9)				(10)			
	Hand Grip											
	L		R		Thumb-finger grip (Palmer)				Thumb-finger grip (tips)			
Momentary hold	250		260		60				60			
Sustained hold	145		155		35				35			
*Elbow angle shown in radians **L = Left, R = Right												
Arm strength (lb)												
(1)	(2)		(3)		(4)		(5)		(6)		(7)	
Degree of elbow flexion (deg)	Pull		Push		Up		Down		In		Out	
	L	R*	L	R	L	R	L	R	L	R	L	R
180	50	52	42	50	9	14	13	17	13	20	8	14
150	42	56	30	42	15	18	18	20	15	20	8	15
120	34	42	26	36	17	24	21	26	20	22	10	15
90	32	37	22	36	17	20	21	26	16	18	10	16
60	26	24	22	34	15	20	18	20	17	20	12	17
Hand and thumb-finger strength (lb)												
	(8)				(9)				(10)			
	Hand Grip											
	L		R		Thumb-finger grip (Palmer)				Thumb-finger grip (tips)			
Momentary hold	56		59		13				13			
Sustained hold	33		35		8				8			
*Left; R = Right												

Figure 3.3.6.4-1. Arm, Hand and Thumb/Finger Strength (5th Percentile Male Data)

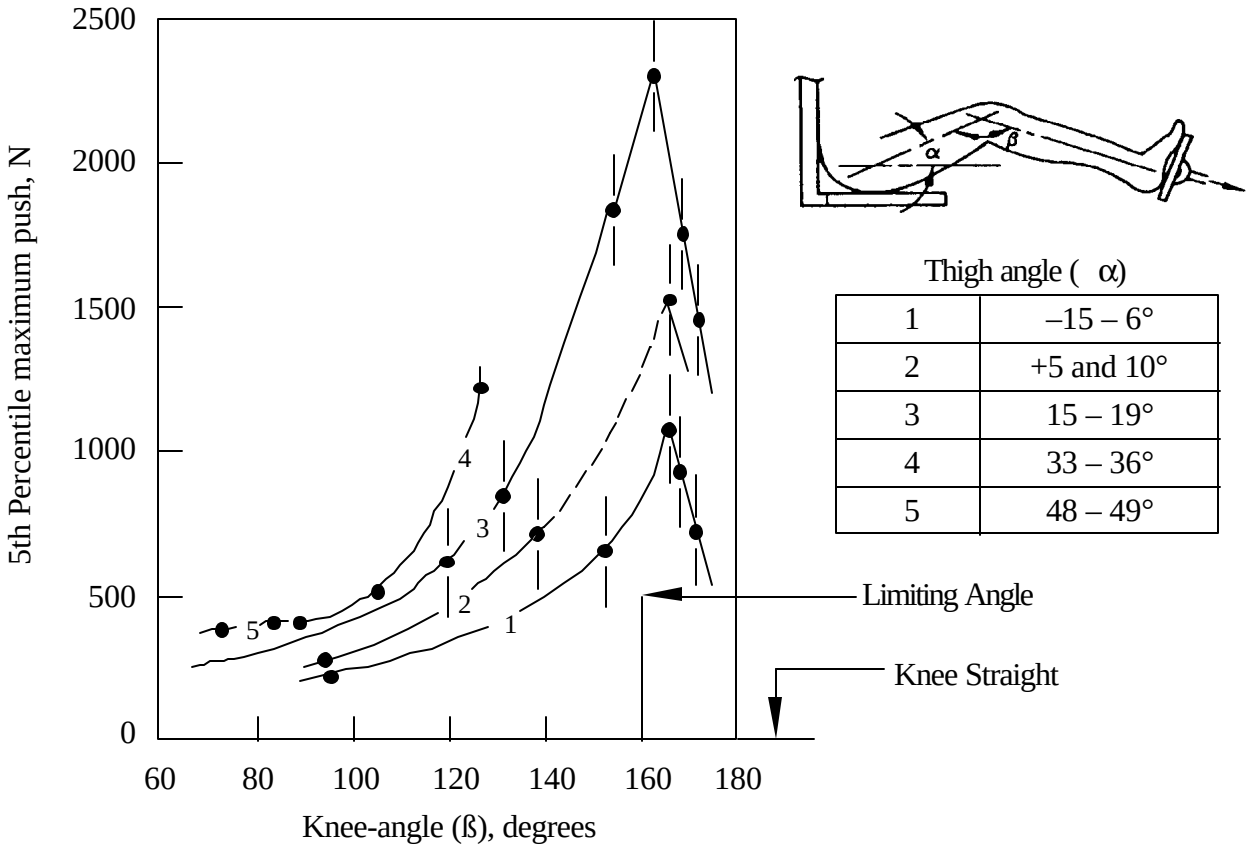
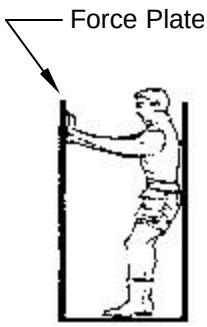


Figure 3.3.6.4-2. Leg Strength at Various Knee and Thigh Angles (5th Percentile Male Data)

	Unpressurized suit, bare handed	
	Mean	SD
Maximum torque: Suppination, Nm (lb-in.)	13.73 (121.5)	3.41 (30.1)
Maximum torque: Pronation, Nm (lb-in.)	17.39 (153.9)	5.08 (45.0)

Figure 3.3.6.4-3. Torque Strength

	Force-plate (1) height	Distances (2)	Force, N (lbf) Means	Force, N (lbf) SD
			Both hands	
	100 percent of shoulder height	50	583 (131)	142 (32)
		60	667 (150)	160 (36)
		70	983 (221)	271 (61)
		80	1285 (289)	400 (90)
		90	979 (220)	302 (68)
		100	645 (145)	254 (57)
			Preferred hand	
		50	262 (59)	67 (15)
		60	298 (67)	71 (16)
		70	360 (81)	98 (22)
		80	520 (117)	142 (32)
		90	494 (111)	169 (38)
		100	427 (96)	173 (39)
		Percent of thumb-tip reach*		
	100 percent of shoulder height	50	369 (83)	138 (31)
		60	347 (78)	125 (28)
		70	520 (117)	165 (37)
		80	707 (159)	191 (32)
		90	325 (73)	133 (30)
		Percent of span**		
	Force-plate (1) height	Distances (2)	Force, N (lbf) Means	Force, N (lbf) SD
	50	100	774 (174)	214 (48)
	50	120	778 (175)	165 (37)
	70	120	818 (184)	138 (31)
	Percent of shoulder height		1-g applicable data	

NOTES:

(1) Height of the center of the force plate - 200 mm (8 in) high by 254 mm (10 in) long - upon which force is applied.
(2) Horizontal distance between the vertical surface of the force plate and the opposing vertical surface (wall or footrest, respectively) against which the subject brace themselves.
(3) Thumb-tip reach - distance from backrest to tip of subject's thumb as thumb and fingertips are pressed together.
(4) Span - the maximal distance between a person's fingertips as he extends his arms and hands to each side.
(5) 1-g data.

Figure 3.3.6.5-1. Maximal Static Push Forces

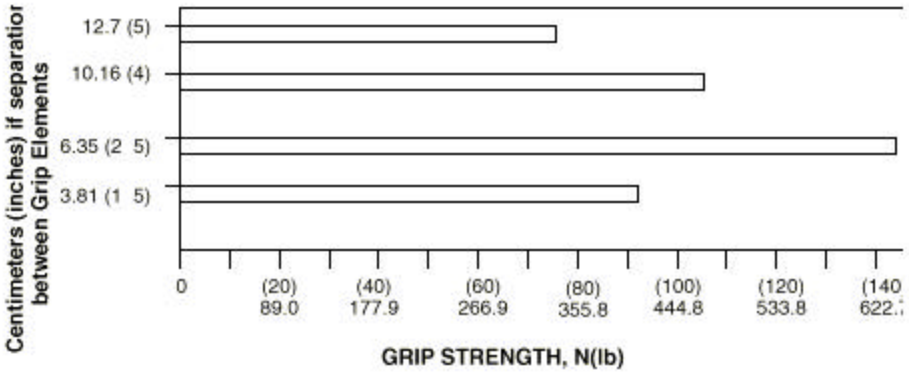


Figure 3.3.6.5-2. Male Grip Strength as a Function of the Separation Between Grip Elements

Minimal finger-access to first joint			
Push button access:	Bare hand: Thermal gloved hand:	32 mm dia (1.26 in.) 38 mm dia (1.5 in.)	
Two finger twist access:	Bare hand: Thermal gloved hand:	object plus 50 mm (1.97 in.) object plus 65 mm (2.56 in.)	

Figure 3.3.6.7-1. Minimum Sizes for Access Openings for Fingers

3.3.6.9 Continuous/Incidental Contact - High Temperature

When payload surfaces whose temperature exceeds 49 °C (120 °F), which are subject to continuous or incidental contact, are exposed to crewmember's bare skin contact, protective equipment shall be provided to the crew, and warning labels shall be provided at the surface site. This also applies to surfaces not normally exposed to the cabin in accordance with the NASA IVA Touch Temperature Safety interpretation letter JSC, MA2-95-048. (LS-71000, Section 6.4.3.2.1)

3.3.6.10 Continuous/Incidental Contact - Low Temperature

When payload surfaces below -18 °C (0 °F), which are subject to continuous or incidental contact, are exposed to crewmember's bare skin contact, protective equipment shall be provided to the crew and warning labels shall be provided at the surface site. This also applies to surfaces not normally exposed to the cabin in accordance with the NASA IVA Touch Temperature Safety interpretation letter JSC, MA2-95-048. (LS-71000, Section 6.4.3.2.2)

3.3.6.11 Equipment Mounting

Equipment items used during nominal operations and planned maintenance shall be designed, labeled, or marked to protect against improper installation. (LS-71000, Section 6.4.4.2.1)

3.3.6.12 Drawers and Hinged Panels

A. Payload ORUs which are pulled out of their installed positions for routine checkout shall be mounted on equipment drawers or on hinged panels. (LS-71000, Section 6.4.4.2.2A)

B. Such drawers or hinged panels shall remain in the "open" position without being supported by hand. (LS-71000, Section 6.4.4.2.2B)

3.3.6.13 Alignment

Payload hardware having blind mate connectors shall provide guide pins or their equivalent to assist in alignment of hardware during installation. (LS-71000, Section 6.4.4.2.3)

3.3.6.14 Slide-Out Stops

Limit stops shall be provided on slide or pivot mounted sub-rack hardware which is required to be pulled out of its installed positions. (LS-71000, Section 6.4.4.2.4)

3.3.6.15 Push-Pull Force

Payload hardware mounted into a capture-type receptacle that requires a push-pull action shall require a force less than 156 N (35 lbf) to install or remove. (LS-71000, Section 6.4.4.2.5)

3.3.6.16 Covers

Where physical access is required, one of the following practices shall be followed, with the order of preference given.

A. Provide a sliding or hinged cap or door where debris, moisture, or other foreign materials might otherwise create a problem. (LS-71000, Section 6.4.4.2.6.1A)

B. Provide a quick-opening cover plate if a cap will not meet stress requirements. (LS-71000, Section 6.4.4.2.6.1B)

3.3.6.17 Self-Supporting Covers

All access covers that are not completely removable shall be self-supporting in the open position. (LS-71000, Section 6.4.4.2.6.2)

3.3.6.18 Accessibility

It shall be possible to mate/demate individual connectors without having to remove or mate/demate other connectors during nominal operations. (LS-71000, Section 6.4.4.3.2A)

3.3.6.19 Ease of Disconnect

A. Not applicable. The RC does not have any connectors that require the crew to mate/demate.

3.3.6.20 Indication of Pressure/Flow

Not applicable to RC.

3.3.6.21 Self Locking

Payload electrical connectors shall provide a self-locking feature. (LS-71000, Section 6.4.4.3.5)

3.3.6.22 Connector Arrangement

Not applicable. The RC does not have any front panel connectors.

3.3.6.23 Arc Containment

Not applicable. The RC does not have any connectors that require the crew to mate/demate.

3.3.6.24 Connector Protection

Not applicable. The RC does not have any connectors that require the crew to mate/demate.

3.3.6.25 Connector Shape

Not applicable. The RC does not have any connectors that require the crew to mate/demate.

3.3.6.26 Fluid and Gas Line Connectors

Not applicable to RC.

3.3.6.27 Alignment Marks or Guide Pins

Mating parts shall have alignment marks in a visible location during mating or guide pins (or their equivalent). (LS-71000, Section 6.4.4.3.11A)

3.3.6.28 Coding

A. The RC shall display a code or identifier on all connectors located on the RC box.

B. The labels or codes on connectors shall be located so they are visible when connected or disconnected. (LS-71000, Section 6.4.4.3.12B)

3.3.6.29 Pin Identification

Each pin shall be uniquely identifiable in each electrical plug and each electrical receptacle. At least every 10th pin must be labeled. (LS-71000, Section 6.4.4.3.13)

3.3.6.30 Orientation

Not applicable. The RC does not have any connectors that require the crew to mate/demate.

3.3.6.31 Hose/Cable Restraints

Not applicable to RC.

3.3.6.32 Non-Threaded Fasteners Status Indication

An indication of correct engagement (hooking, latch fastening, or proper positioning of interfacing parts) of non-threaded fasteners shall be provided. (LS-71000, Section 6.4.4.4.1)

3.3.6.33 Mounting Bolt/Fastener Spacing

Clearance around fasteners to permit fastener hand threading (if necessary) shall be a minimum of 0.5 inches for the entire circumference of the bolt head and a minimum of 1.5 inches over 180 degrees of the bolt head and provide the tool handle sweep as seen in Figure 3.3.6.33-1. Excepted are National Space Transportation System (NSTS) standard middeck lockers or payload-provided hardware with the static envelope dimensions (cross-section) as specified in Figures 3.4.2.1-1, 3.4.2.2-1 and 3.4.2.3-1 of NSTS-21000-IDD-MDK and other similar captive fastener arrangements. (LS-71000, Section 6.4.4.4.2)

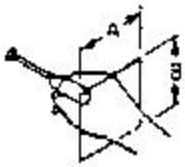
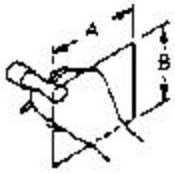
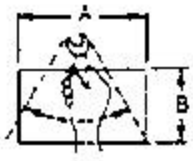
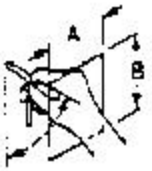
Opening dimensions		Task
	A 117 mm (4.6 in) B 107 mm (4.2 in)	Using common screwdriver with freedom to turn hand through 180°
	A 133 mm (5.2 in) B 115 mm (4.5 in)	Using pliers and similar tools
	A 155 mm (6.1 in) B 135 mm (5.3 in)	Using T-handle wrench with freedom to turn wrench through 180°
	A 203 mm (8.0 in) B 135 mm (5.3 in)	Using open-end wrench with freedom to turn wrench through 62°
	A 122 mm (4.8 in) B 155 mm (6.1 in)	Using Allen-type wrench with freedom to turn wrench through 62°

Figure 3.3.6.33-1. Minimal Clearance for Tool-Operated Fasteners

3.3.6.34 Multiple Fasteners

When several fasteners are used on one item they shall be of identical type. (LS-71000, Section 6.4.4.4.3)

NOTE: Phillips or Torque-Set fasteners may be used where fastener installation is permanent relative to planned on-orbit operations or maintenance, or where tool-fastener interface failure can be corrected by replacement of the unit containing the affected fastener with a spare unit.

3.3.6.35 Captive Fasteners

Exception - there are four mounting bolts and 4 launch bolts that will be removed and discarded once the RC is on orbit.

All fasteners planned to be installed and/or removed on-orbit shall be captive when disengaged. (LS-71000, Section 6.4.4.4.4)

3.3.6.36 Quick Release Fasteners

A. Quick release fasteners shall require a maximum of one complete turn to operate (quarter - turn fasteners are preferred). (LS-71000, Section 6.4.4.4.5A)

B. Quick release fasteners shall be positive locking in open and closed positions. (LS-71000, Section 6.4.4.4.5B)

3.3.6.37 Threaded Fasteners

Only right handed threads shall be used. (LS-71000, Section 6.4.4.4.6)

3.3.6.38 Over Center Latches

A. Nonself-latching - Over center latches shall include a provision to prevent undesired latch element realignment, interface, or reengagement. (LS-71000, Section 6.4.4.4.7A)

B. Latch lock - Latch catches shall have locking features. (LS-71000, Section 6.4.4.4.7B)

C. Latch handles - If the latch has a handle, the latch handle and latch release shall be operable by one hand. (LS-71000, Section 6.4.4.4.7C)

3.3.6.39 Winghead Fasteners

Winghead fasteners shall fold down and be retained flush with surfaces. (LS-71000, Section 6.4.4.4.8)

3.3.6.40 Fastener Head Type

A. Hex type external or internal grip or combination head fasteners shall be used where on-orbit crew actuation is planned, e.g., ORU replacement. (LS-71000, Section 6.4.4.4.9A)

B. If a smooth surface is required, flush or oval head internal hex grip fasteners shall be used for fastening. (LS-71000, Section 6.4.4.4.9B)

C. Slotted fasteners shall not be used to carry launch loads for hard-mounted equipment. Slotted fasteners are allowed in non-structural applications (e.g., computer data connectors, stowed commercial equipment). (LS-71000, Section 6.4.4.4.9C)

3.3.6.41 One-Handed Actuation

Fasteners planned to be removed or installed on-orbit shall be designed and placed so they can be mated/demated using either hand. (LS-71000, Section 6.4.4.4.10)

3.3.6.42 Reserved

3.3.6.43 Access Holes

Covers or shields through which mounting fasteners must pass for attachment to the basic chassis of the unit shall have holes for passage of the fastener without precise alignment (and hand or necessary tool if either is required to replace). (LS-71000, Section 6.4.4.4.12)

3.3.6.44 Controls Spacing Design Requirements

All spacing between controls and adjacent obstructions shall meet the minimum requirements as shown in Figure 3.3.6.44-1, Control Spacing Requirements for Ungloved Operation. (LS-71000, Section 6.4.5.1)

3.3.6.45 Accidental Activation

Requirements for reducing accidental actuation of controls are defined as follows:

3.3.6.45.1 Protective Methods

Payloads shall provide protection against accidental control actuation using one or more of the protective methods listed in sub-paragraphs A through G below. Infrequently used controls (i.e., those used for calibration) should be separated from frequently used controls. Leverlock switches or switch covers are strongly recommended for switches related to mission success. Switch guards may not be sufficient to prevent accidental actuation. (LS-71000, Section 6.4.5.2.1)

NOTE: Displays and controls used only for maintenance and adjustments, which could disrupt normal operations if activated, should be protected during normal operations; e.g., by being located separately or guarded/covered.

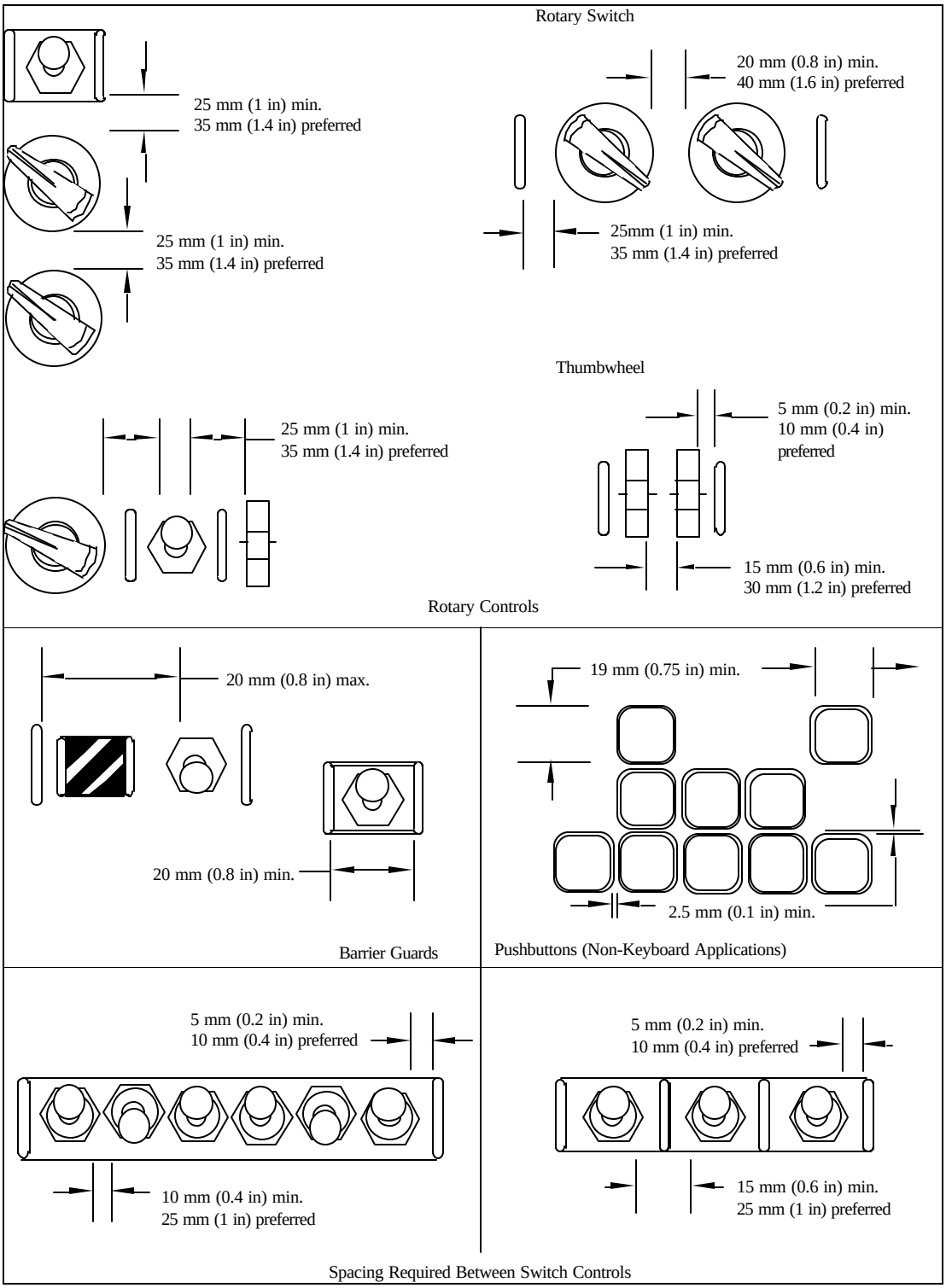


Figure 3.3.6.44-1. Control Spacing Requirements for Ungloved Operation

A. Locate and orient the controls so that the operator is not likely to strike or move them accidentally in the normal sequence of control movements. (LS-71000, Section 6.4.5.2.1A)

B. Recess, shield, or otherwise surround the controls by physical barriers. The control shall be entirely contained within the envelope described by the recess or barrier. (LS-71000, Section 6.4.5.2.1B)

C. Cover or guard the controls. Safety or lock wire shall not be used. (LS-71000, Section 6.4.5.2.1C)

D. Cover guards when open shall not cover or obscure the protected control or adjacent controls. (LS-71000, Section 6.4.5.2.1D)

E. Provide the controls with interlocks so that extra movement (e.g., lifting switch out of a locked detent position) or the prior operation of a related or locking control is required. (LS-71000, Section 6.4.5.2.1E)

F. Provide the controls with resistance (i.e., viscous or coulomb friction, spring-loading, or inertia) so that definite or sustained effort is required for actuation. (LS-71000, Section 6.4.5.2.1F)

G. Provide the controls with a lock to prevent the control from passing through a position without delay when strict sequential actuation is necessary (i.e., the control moved only to the next position, then delayed). (LS-71000, Section 6.4.5.2.1G)

3.3.6.45.2 Noninterference

Payload provided protective devices shall not cover or obscure other displays or controls. (LS-71000, Section 6.4.5.2.2)

3.3.6.45.3 Dead-Man Controls

Dead-man controls are covered under NSTS 1700.7B, ISS Addendum paragraphs 200.4a and 303.2. (LS-71000, Section 6.4.5.2.3)

3.3.6.45.4 Barrier Guards

Barrier guard spacing shall adhere to the requirements for use with the toggle switches, rotary switches, and thumbwheels as shown in Figures 3.3.6.44-1, Control Spacing Requirements for Ungloved Operation and 3.3.6.45.4-1, Rotary Switch Guard. (LS-71000, Section 6.4.5.2.4)

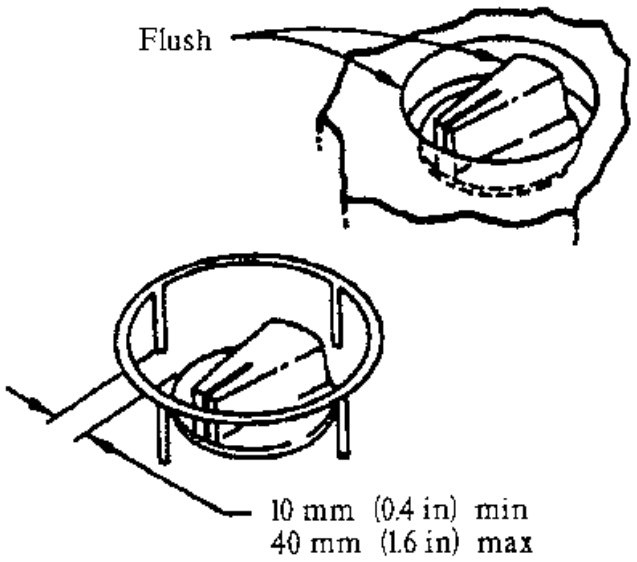


Figure 3.3.6.45.4-1. Rotary Switch Guard

3.3.6.45.5 Recessed Switch Protection

When a barrier guard is not used, rotary switches that control critical functions shall be recessed as shown in Figure 3.3.6.45.4-1, Rotary Switch Guard. (LS-71000, Section 6.4.5.2.5)

3.3.6.46 Position Indication

When payload switch protective covers are used, control position shall be evident without requiring cover removal. (LS-71000, Section 6.4.5.2.7)

3.3.6.47 Hidden Controls

Controls that cannot be directly viewed will be avoided. If present, hidden controls shall be guarded to protect against inadvertent actuation. (LS-71000, Section 6.4.5.2.8)

3.3.6.48 Hand Controllers

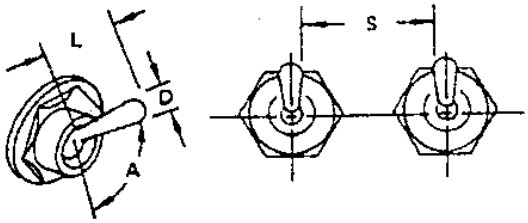
Not applicable to RC.

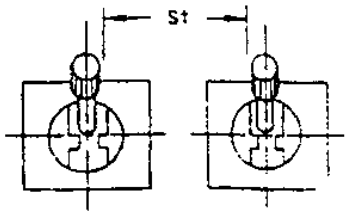
3.3.6.49 Valve Controls

Not applicable to RC.

3.3.6.50 Toggle Switches

Dimensions for a standard toggle switch shall conform to the values presented in Figure 3.3.6.50-1, Toggle Switches. (LS-71000, Section 6.4.5.4)





	Dimensions		Resistance	
	L Arm length	D Control tip	Small switch	Large switch
Minimum	13 mm (1/2 in)	3mm (1/8 in)	2.8 N (10 oz)	2.8 N (10 oz)
Maximum	50 mm (2 in)	25 mm (1 in)	4.5 N (16 oz)	11 N (40 oz)

	Displacement between positions	
	2 position	A 3 position
Minimum	30°	17°
Maximum	80°	40°
Desired		25°

	Separation			
	Single finger operation †		S Single finger sequential operation	Simultaneous operation by different fingers
Minimum	19 mm (3/4 in)	25 mm (1 in)	13 mm (1/2 in)	16 mm (5/8 in)
Optimum	50 mm (2 in)	50 mm (2 in)	25 mm (1 in)	19 mm (3/4 in)

† Using a lever lock toggle switch

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Reference: 2, page 93

Figure 3.3.6.50-1. Toggle Switches

3.3.6.51 Restraints and Mobility Aids

Payloads shall be designed such that all installation, operation, and maintenance can be performed using standard crew restraints, mobility aids, and interfaces as defined in SSP 30257:004. (LS-71000, Section 6.4.6)

3.3.6.51.1 Stowage Drawer Contents Restraints

Not applicable to RC.

3.3.6.51.2 Stowage and Equipment Drawers/Trays

Not applicable to RC.

3.3.6.51.3 Captive Parts

Payloads and payload equipment shall be designed in such a manner to ensure that all unrestrained parts (e.g., locking pins, knobs, handles, lens covers, access plates, or similar devices) that may be temporarily removed on orbit will be tethered or otherwise held captive. (LS-71000, Section 6.4.6.3)

3.3.6.51.4 Handle and Grasp Area Design Requirements

Not applicable to Refrigerated Centrifuge.

3.3.6.52 Electrical Hazards

Electrical equipment other than bioinstrumentation equipment will incorporate the following controls as specified below:

A. If the exposure condition is below the threshold for shock (i.e., below maximum leakage current and voltage requirements as defined within this section), no controls are required. Non-patient equipment with internal voltages not exceeding 30 volts rms or DC nominal (32 volts rms or DC maximum) will contain potentials below the threshold for electrical shock. (LS-71000, Section 6.4.9.1A)

B. If the exposure condition exceeds the threshold for shock, but is below the threshold of the let-go current profile (critical hazard) as defined in Table 3.3.6.52-1, two independent controls (e.g., a safety (green) wire, bonding, insulation, leakage current levels below maximum requirements) shall be provided such that no single failure, event, or environment can eliminate more than one control. (LS-71000, Section 6.4.9.1B)

C. If the exposure condition exceeds both the threshold for shock and the threshold of the let-go current profile (catastrophic hazardous events), as defined in Table 3.3.6.52-1, three independent controls shall be provided such that no combination of two failures, events or environments can eliminate more than two controls. (LS-71000, Section 6.4.9.1C)

D. If two dependent controls are provided, the physiological effect that a crew member experiences as a result of the combinations of the highest internal voltage applied to or generated within the equipment and the frequency and wave form associated with a worst case credible failure shall be below the threshold of the let-go current profile as defined in Table 3.3.6.52-1. (LS-71000, Section 6.4.9.1D)

E. If it cannot be demonstrated that the hazard meets the conditions of paragraph A, B, or C above, three independent hazard controls shall be provided such that no combination of two failures, events or environments can eliminate more than two controls. (LS-71000, Section 6.4.9.1E)

TABLE 3.3.6.52-1. LET-GO CURRENT PROFILE, THRESHOLD VERSUS FREQUENCY

Frequency (Hertz)	**Maximum Total Peak Current (AC + DC components combined) milliamperes**
DC	40.0
15	8.5
2000	8.5
3000	13.5
4000	15.0
5000	16.5
6000	17.9
7000	19.4
8000	20.9
9000	22.5
10000	24.3
50000	24.3
(Based on 99.5 Percentile Rank of Adults)	

3.3.6.52.1 Mismatched

Not applicable. The RC does not have any connectors that require the crew to mate/demate.

3.3.6.52.2 Overload Protection

3.3.6.52.2.1 Device Accessibility

An overload protective device shall not be accessible without opening a door or cover, except that an operating handle or operating button of a circuit breaker, the cap of an extractor-type fuse holder, and similar parts may project outside the enclosure. (LS-71000, Section 6.4.9.1.2.1)

3.3.6.52.2.2 Extractor -Type Fuse Holder

The design of the extractor-type fuse holder shall be such that the fuse is extracted when the cap is removed. (LS-71000, Section 6.4.9.1.2.2)

3.3.6.52.2.3 Overload Protection Location

Overload protection (fuses and circuit breakers) intended to be manually replaced or physically reset on-orbit shall be located where they can be seen and replaced or reset without removing other components. (LS-71000, Section 6.4.9.1.2.3)

3.3.6.52.2.4 Overload Protection Identification

Each overload protector (fuse or circuit breaker) intended to be manually replaced or physically reset on-orbit shall be readily identified or keyed for its proper value. (LS-71000, Section 6.4.9.1.2.4)

3.3.6.52.2.5 Automatic Restart Protection

Controls shall be employed that prevent automatic restarting after an overload-initiated shutdown. (LS-71000, Section 6.4.9.1.2.5)

3.3.6.53 Audio Devices (Displays)

Not applicable to RC.

3.3.6.54 Egress

All payload egress requirements shall be in accordance with NSTS 1700.7B, ISS Addendum, paragraph 205. (LS-71000, Section 6.4.9.11)

3.3.7 System Security

3.3.8 Design Requirements

3.3.8.1 Structural Design Requirements

3.3.8.1.1 On-orbit Loads

A. The RC shall provide positive margins of safety for on-orbit loads of 0.2 Gs acting in any direction. (LS-71000, Section 6.2.1.1.4A)

B. The RC shall provide positive margins of safety when exposed to the crew induced loads defined in Table 3.3.9.1.1-1, Crew-Induced Loads. (LS-71000, Section 6.2.1.1.4B)

TABLE 3.3.9.1.1-1. CREW-INDUCED LOADS

Crew System or Structure	Type of Load	Load	Direction of Load
Levers, Handles, Operating Wheels, Controls	Push or Pull concentrated on most extreme edge	222.6 N (50 lbf), limit	Any direction
Small Knobs	Twist (torsion)	14.9 N-m (11 ft-lbf), limit	Either direction
Exposed Utility Lines (Gas, Fluid, and Vacuum)	Push or Pull	222.6 N (50 lbf)	Any direction
Rack front panels and any other normally exposed equipment	Load distributed over a 4 inch by 4 inch area	556.4 N (125 lbf), limit	Any direction
Legend: ft = feet, m = meter, N = Newton, lbf = pounds force			

3.3.8.1.2 Safety Critical Structures Requirements

The RC shall be designed in accordance with the requirements specified in SSP 52005. (LS-71000, Section 6.2.1.1.1)

3.3.8.1.3 First Modal Frequency

SIR drawer instruments shall have a first modal frequency of not less than 35 Hz for launch and landing, based on rigidly mounting the instrument at the rack to SIR drawer instrument interface. (LS-71000, Section 6.2.1.1.2)

3.3.8.1.4 Launch and Landing Loads

A. For design and qualification purposes, SIR drawer instruments shall maintain positive margins of safety for the MPLM ascent random vibration environment as defined in Table 3.3.8.1.4-2, "Random Vibration Criteria for HRF Rack Post Mounted Equipment Weighing More Than 100 Pounds in the MPLM." (LS-71000, Section 6.2.1.1.3A)

TABLE 3.3.8.1.4-2. RANDOM VIBRATION CRITERIA FOR HRF RACK POST MOUNTED EQUIPMENT WEIGHING MORE THAN 100 POUNDS IN THE MPLM

Frequency	Level
20 Hz	0.002 g^2/Hz
20-70 Hz	+4.8 dB/oct
70-150 Hz	0.015 g^2/Hz
150-2000 Hz	-3.7 dB/oct
2000 Hz	0.0006 g^2/Hz
Composite	2.4 grms

NOTE: Criteria is the same for all directions (X, Y, Z)

B. SIR drawer instruments shall maintain positive margins of safety for the launch and landing conditions in the MPLM. For early design, the acceleration environment defined in Table 3.3.8.1.4-3, "HRF Rack Mounted Equipment Load Factors (Equipment Frequency 35 Hz)" will be used. These load factors will be superseded by load factors obtained through ISS-performed Coupled Loads Analysis as described in SSP 52005. (LS-71000, Section 6.2.1.1.3B)

TABLE 3.3.8.1.4-3. HRF RACK MOUNTED EQUIPMENT LOAD FACTORS (EQUIPMENT FREQUENCY 35 HZ)

Liftoff	**X**	**Y**	**Z**
(g)	±7.7	±11.6	±9.9
Landing	**X**	**Y**	**Z**
(g)	±5.4	±7.7	±8.8

NOTE: Load factors apply concurrently in all possible combinations for each event and are shown in the rack coordinate system defined in SSP 41017, Part 2, paragraph 3.1.3.

3.3.8.2 Electrical Power Consuming Equipment Design

3.3.8.2.1 Batteries

All battery systems shall meet the requirements of NSTS 1700.7, ISS addendum, Section 213.2. (Derived from LS-71000, Section 6.2.2.14)

3.4 ACCEPTANCE AND QUALIFICATION REQUIREMENTS

3.4.1 Nominal Operation Under Thermal Environment

A. The RC shall operate in accordance with work authorizing documents during exposure to cabin air temperatures of 63 ^{o}F to 82 ^{o}F given a payload air inlet temperature of 89.6 ^{o}F.

B. The RC shall operate in accordance with work authorizing documents under the conditions in 3.4.1.A following exposure to cabin air temperatures of 50 ^{o}F to 115 ^{o}F.

3.4.2 Vibration and Sine Sweep

A. The RC shall perform a sinusoidal resonance survey.

B. The RC shall operate nominally following vibration at flight vibration loads.

C. The RC shall operate nominally following vibration at workmanship loads.

3.4.3 Functional Performance

The RC shall operate in accordance with work authorizing documents under all planned modes of operation.

3.4.4 Electrical, Electronic, and Electromechanical Parts Control, Selection, and Burn-In

A. Parts control shall be in accordance with SSP 30312, "Electrical, Electronic, and Electromechanical (EEE) and Mechanical Parts Management and Implementation Plan for Space Station Program."

B. Parts selection for equipment shall be in accordance with:

(1) SSP-30423, "Space Station Approved Electrical, Electronic, and Electromechanical (EEE) Parts List."

(2) SSQ-25002, "Supplemental List of Qualified Electrical, Electronic, Electromechanical (EEE) Parts, Manufacturers, and Laboratories (QEPM&L)."

(3) Semiconductors shall be JANTXV in accordance with MIL-S-19500, "General Specifications for Semiconductor Devices." Diodes shall have a metallurgical bond. Passive parts shall be at least the second highest level of appropriate Military Established Reliability (MIL-ER).

(4) SSP-30512C, "Space Station Ionizing Radiation Design Environment." Where no alternative is available, nonmilitary parts, components, and subassemblies may be used, but burn-in screening of these items shall be performed per 3.4.4C.

C. Burn-in screening shall be completed (100%) on all flight hardware (units) at 35°. See Section 4.3.4 for verification procedure.

3.4.5 Flammability

Refrigerated Centrifuge shall meet the flammability test requirements as described in 4.3.5.

3.4.6 Offgassing

Refrigerated Centrifuge located in inhabitable areas shall meet the offgassing test requirements as described in 4.3.6.

3.4.7 Shock

Not applicable to RC.

3.4.8 Bench Handling

Refrigerated Centrifuge shall meet the requirements as described in 4.3.8.

3.4.9 Payload Mass

Refrigerated Centrifuge shall meet the payload mass control requirements as described in 4.3.9.

3.4.10 Electromagnetic Compatibility

Refrigerated Centrifuge shall meet the EMC control requirements as described in 4.3.10.

3.4.11 Acoustic Noise

Refrigerated Centrifuge shall meet the acoustic noise control requirements as described in 4.3.11.

3.4.12 Safety Critical Structural Verification

Not applicable to the RC.

3.4.13 Pre-Delivery Acceptance

Refrigerated Centrifuge shall meet the pre-delivery acceptance (PDA) requirements as described in 4.3.12.

3.5 HUMAN RESEARCH FACILITY PROGRAM REQUIREMENTS

3.5.1 Safety

The RC shall meet the applicable requirements of NSTS 1700.7, NSTS 1700.7 ISS Addendum, NSTS/ISS 18798, NSTS/ISS 13830, and KHB 1700.7.

3.5.2 Documentation Requirements

Documentation requirements for RC shall be as specified in Appendix A of the Program Requirements Document (PRD) for HRF, LS-71000. Required items for submittal to NASA are summarized below for convenience.

3.5.2.1 Acceptance Data Package

The contents of the Acceptance Data Package (ADP) shall meet the intent of SSP 30695, Acceptance Data Package Requirements Specification.

3.5.2.2

The SOW for procured flight items shall contain a DRD specifying the above ADP contents.

4.0 VERIFICATION PROVISIONS

This section contains the required verification methods for ISS interface certification, science functional acceptance, and program qualification and acceptance. Section 4.1 addresses definitions for terms used herein.

Appendix B contains the applicability matrix for ISS Pressurized Payload Interface Requirements Document requirements. The Verification Data Sheet addressing the appropriate method for ISS interface verification is also contained in Appendix B. If an alternate verification method is desired, the new verification method must be negotiated in the Unique Payload Verification Plan (PVP).

Section 4.2 contains the verification methods for science functional acceptance. Appendix C contains the applicability matrix for science functional requirements.

Section 4.3 contains the verification methods for program qualification and acceptance requirements. Appendix D contains the applicability matrices for acceptance and qualification requirements.

The responsibility for the performance of all verification activities is as specified in Appendices B, C, and D. All testing described in Appendices B, C, and D shall be documented via Task Performance Sheet (TPS) (JSC Form 1225) per JSC Work Instruction NT1-CWI-001. Except as otherwise specified in the contract, the provider may use their own or any other facility suitable for the performance of the verification requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the verifications set forth in this specification.

4.1 GENERAL

Equipment verification methods are defined as follows:

A. Inspection is a method that determines conformance to requirements by the review of drawings, data or by visual examination of the item using standard quality control methods, without the use of special laboratory procedures.

B. Analysis is a process used in lieu of, or in addition to, other methods to ensure compliance to specification requirements. The selected techniques may include, but not be limited to, engineering analysis, statistics and qualitative analysis, computer and hardware simulations, and analog modeling. Analysis may also include assessing the results of lower level qualification activity. Analysis may be used when it can be determined that (1) rigorous and accurate analysis is possible, (2) test is not cost effective, and (3) verification by inspection is not adequate.

   Verification by similarity is the process of analyzing the specification criteria for hardware configuration and application for an article to determine if it is

similar or identical in design, manufacturing process, and quality control to an existing article that has previously been qualified to equivalent or more stringent specification criteria. Special effort will be made to avoid duplication of previous tests from this or similar programs. If the previous application is considered to be similar, but not equal to or greater in severity, additional qualification tests shall concentrate on the areas of new or increased requirements.

C. Demonstration consists of a qualitative determination of the properties of a test article. This qualitative determination is made through observation, with or without special test equipment or instrumentation, which verifies characteristics such as human engineering features, services, access features, and transportability. Demonstration requirements are normally implemented within a test plan, operations plan, or test procedure.

D. Test is a method in which technical means, such as the use of special equipment, instrumentation, simulation techniques, and the application of established principles and procedures, are used for the evaluation of components, subsystems, and systems to determine compliance with requirements. Test shall be selected as the primary method when analytical techniques do not produce adequate results; failure modes exist which could compromise personnel safety, adversely affect flight systems or payload operation, or result in a loss of mission objectives; or for any components directly associated with Space Station and orbiter interfaces. The analysis of data derived from tests is an integral part of the test program, and should not be confused with analysis as defined above.

4.2 FUNCTIONAL PERFORMANCE ACCEPTANCE TESTING

The requirements herein describe specific test requirements for functional performance acceptance.

4.3 ACCEPTANCE AND QUALIFICATION VERIFICATION METHODS

The requirements herein describe specific test requirements for Refrigerated Centrifuge acceptance and qualification. Qualification testing shall only be performed on the qualification unit. If no qualification articles exist for the hardware, analysis shall be used to qualify the design.

4.3.1 Thermal Cycle Tests

HRF payloads undergoing thermal cycle testing shall be functionally tested at each stable temperature and during transitions. The pass-fail criteria for the functional test and the definition of the functional test will be equipment unique and shall be defined in the test plan and test procedure. Functional tests shall be conducted on end items prior to, during, and after environmental exposure. (LS-71000, Section 5.4.1.1.6)

4.3.1.1 Qualification Thermal Cycling

The Qualification Thermal Cycle Test shall be over a range of 110 °F (61.1 °C) centered about the normal operating temperature of 75 °F (23.9 °C). The Qualification thermal test shall consist of 7½ cycles. One cycle is defined as starting from normal operating temperature, increasing to the maximum high temperature, decreasing to the minimum low temperature and then returning to the normal operating temperature as depicted in Figure 4.3.1.1-1. The complete test is seven and one-half (7½) cycles with one-hour soaks at each extreme. The hardware will be functionally tested during transitions and at the highest and lowest temperature extremes, consistent with the defined operating temperature range. The hardware shall not be functionally tested at temperatures in excess of the defined operating temperature range. (Hardware shall be unpowered when outside the manufacturer's operating limits.) The specific profile shall be defined in the individual test plans. (LS-71000, Section 5.4.1.1.6.1)

4.3.1.2 Acceptance Thermal Cycling Test

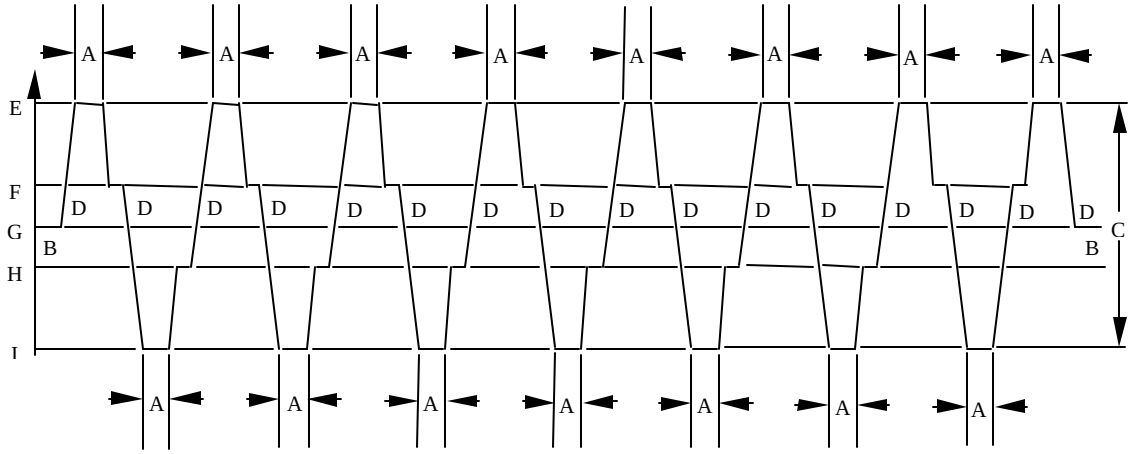
An acceptance thermal test shall be preformed on all flight and flight alternate hardware. The acceptance thermal cycle shall be conducted over a temperature range of 100 °F (55.6 °C) centered about the hardware normal operating temperature of 75 °F (23.9 °C) or as defined in the test plan. The hardware shall be functionally tested before and after the temperature test, at each transition, and at each stable temperature. The hardware shall not be functionally tested at temperatures in excess of the defined operating temperature range. (Hardware shall be unpowered when outside the manufacturer's operating limits.) One cycle is defined as starting from normal operating temperature, increasing to the maximum high temperature, decreasing to the minimum low temperature and then returning to the normal operating (LS-71000, Section 5.4.1.1.6.2) temperature as depicted in Figure 4.3.1.2-1. The complete test consists of one and one-half (1½) thermal cycles with one-hour soaks at each extreme. Minimum temperature sweep shall be 100°F around the normal operating temperature, and the hardware shall dwell at the temperature extremes for a minimum of 1 hour. (LS-71000, Section 5.4.1.1.6.2)

4.3.2 Vibration Tests

Qualification for Acceptance Random Vibration Test levels are as described in Section 4.3.2.1. Acceptance Random Vibration Test levels are as described in Section 4.3.2.2.

4.3.2.1 Sinusoidal Resonance Survey

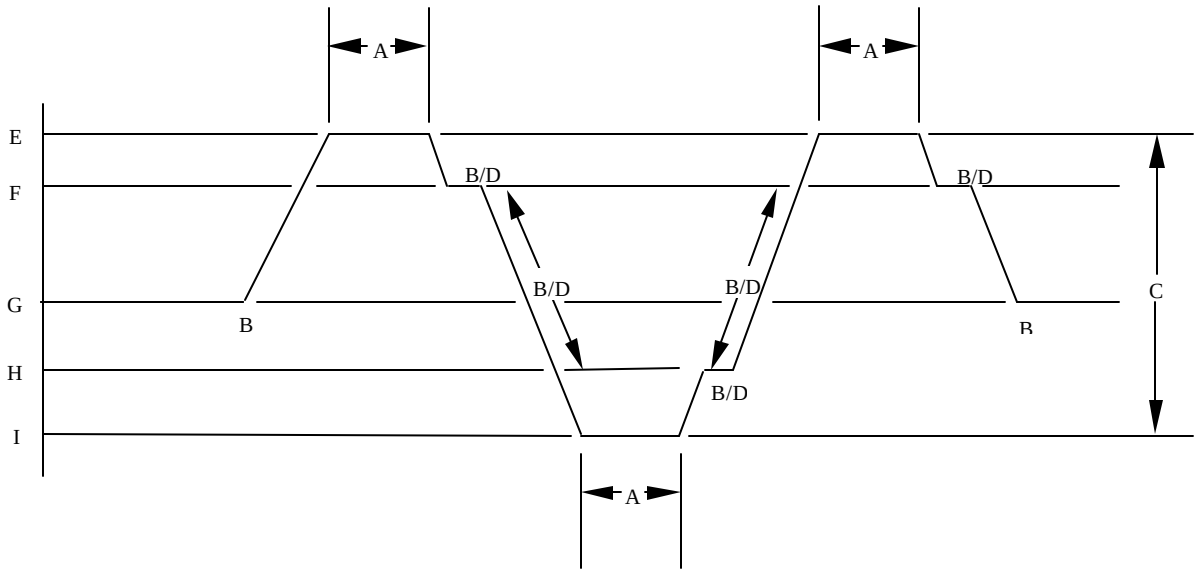
The RC shall be subjected to a sinusoidal resonance survey to determine the fundamental resonance frequencies of the test article. The survey shall be conducted at a sweep rate of one octave per minute in each of three orthogonal



NOTES:

1. A = Time to stabilize equipment temperature plus 1-hour minimum.
2. B = Functional tests to be performed as shown.
3. C = Control temperature range between high and low acceptance test conditions shall be a minimum of 61.11°C (110°F). Contractor is to specify tolerances on stable temperature periods.
4. D = Simplified Functional Test. Rate of temperature change during temperature transition shall not be less than 0.55°C (1°F)/min. nor greater than 2.22°C (4°F) (4°F)/min.
5. E = Median operational temperature plus 30.56°C (55°F).
6. F = Maximum operational temperature.
7. G = Median operational temperature.
8. H = Minimum operational temperature.
9. I = Median operational temperature minus 30.56°C (55°F).

Figure 4.3.1.1-1. Qualification Thermal Cycling



NOTES:

1. A = Time to stabilize equipment temperature plus 1-hour minimum.
2. B = Functional tests to be performed as shown.
3. C = Control temperature range between high and low acceptance test conditions shall be a minimum of 55.56°C (100°F). Contractor is to specify tolerances on stable temperature periods.
4. D = Simplified Functional Test. Rate of temperature change during temperature transition shall not be less than 0.55°C (1°F)/min. nor greater than 2.22°C (4°F) (4°F)/min.
5. E = Median operational temperature plus 27.78°C (50°F).
6. F = Maximum operational temperature.
7. G = Median operational temperature.
8. H = Minimum operational temperature.
9. I = Median operational temperature minus 27.78°C (50°F).

Figure 4.3.1.2-1. Acceptance Thermal Cycling

axes from 5 to 200 Hz, one sweep up and down, with an input not to exceed 0.25 g zero to peak. The equipment under test shall have an accelerometer mounted at an accessible hard point on the test item near or on the center of gravity (CG) of the test article. The output of this response accelerometer shall be monitored and not allow the hardware to experience more than 0.5 g peak. The input acceleration level shall be monitored by an accelerometer mounted as close as possible to the test fixture/hardware interface. (LS-71000, Section 5.4.1.1.2)

4.3.2.2 Random Vibration Test

Random vibration testing is required for all HRF rack mounted hardware. Random vibration testing is not required for hardware packed in vibration damping materials such as foam, or for hardware launched in soft stowage containers. Each HRF instrument subjected to vibration testing shall be functionally tested before and after vibration testing. It is also preferred that the hardware be operating and functionally tested during vibration testing. An assessment of the impact of operating the hardware during vibration testing shall be conducted and recommendations presented. The pass-fail criteria for the functional test and the definition of the functional test will be equipment unique and shall be defined in the test plan and test procedure for each element. (LS-71000, Section 5.4.1.1.3)

It is recommended that the hardware be hard mounted to the vibration test fixture in order to achieve a one-to-one transfer of the vibration levels shown in the following paragraphs. If the individual hardware flight mounting configuration is expected to result in amplification of flight vibration levels above the test levels defined in the following paragraphs, a test program should be developed that verifies the survivability of the hardware. (LS-71000, Section 5.4.1.1.3)

Requirements for qualification vibration testing are defined in SSP 52005. Requirements for acceptance vibration testing are defined in SP-T-0023. (LS-71000, Section 5.4.1.1.3)

4.3.2.2.1 Qualification Random Vibration Test

Qualification Vibration Test (QVT) certifies the design for a number of launch cycles determined by the duration of the vibration test in each axis. QVT shall be conducted on dedicated qualification test hardware only. Spectral density and frequency of QVT vibration levels shall be equivalent to expected flight levels. The QVT requirement for vibration is identical to Section 3.3.8.1.4A.

The duration of the QVT shall be four times the expected life time exposure to flight vibration, but not less than 60 sec per axis. Hardware may be certified for additional launch cycles by increasing vibration duration by 30 seconds in each axis for each additional launch cycle required. HRF requires a minimum duration of 180 seconds in each axis. The flight level vibrations for QVT are shown in Table 4.3.2.2.1-1.

Frequency	Level
20 Hz	0.005 g^2/Hz
20-70 Hz	+5 dB/octave
70-350 Hz	0.004 g^2/Hz
350-2000 Hz	-3.9 dB/octave
2000 Hz	0.002 g^2/Hz
Composite	2.4 g RMS

4.3.2.2.2 Qualification for Acceptance Random Vibration Test

Qualification for Acceptance Vibration Testing (QAVT) determines the number of Acceptance Vibration Testing (AVT) that may be conducted on flight units. QAVT shall be conducted on dedicated qualification test hardware only. QAVT shall be conducted at 1.69 times AVT vibration levels. QAVT vibration duration criteria shall be the AVT vibration duration times the number of AVT for which the hardware is to be qualified. Duration shall be 60 seconds per axis.

Frequency	Level
20 Hz	0.017 g^2/Hz
20-80 Hz	+3 dB/octave
80-350 Hz	.067 g^2/Hz
350-2000 Hz	-3 dB/octave
2000 Hz	.012 g^2/Hz
Composite	7.9 g RMS

4.3.2.2.3 Acceptance Random Vibration Test

AVT is used to screen defects in workmanship that cannot be detected by inspection. AVT for RC shall be performed at a 6.1 g rms composite level over the frequency range and minimum AVT levels defined in Table 4.3.2.2.3-1. Vibration duration shall be a minimum of 60 seconds in each of three axes. Functional/continuity tests shall be conducted on components before, during, and after the AVT. (LS-71000 Section 5.4.1.1.3.3)

TABLE 4.3.2.2.3-1. ACCEPTANCE RANDOM VIBRATION WORKMANSHIP TEST LEVELS

Frequency Range (Hz)	**Minimum Power Spectral Density (g^2/Hz)**
20	0.01
20 - 80	+3 dB/Octave - Slope
80 - 350	0.04
350 - 2000	-3 dB/Octave - Slope
2000	0.007
Composite	6.1 g rms

4.3.3 Functional Testing

Abbreviated and full functional test procedures shall be as specified in a TPS or a released procedure.

Functional tests are performed to validate the operation of the RC flight hardware. Functionals make up the core of certain tests and can be performed before and after environmental testing. The functional test done prior to testing establishes the functional state (or baseline) of the hardware while the functional done after testing evaluates its ability to withstand the test levels.

An abbreviated functional will be used to test the functional state of the hardware during some environmental testing (i.e., thermal, vibration, bench handling, etc.). The intended use of an abbreviated functional is to verify nominal hardware function between test stages.

4.3.4 Electrical, Electronic, and Electromechanical Parts Control, Selection, and Burn-In

A Compliance with 3.4.4.A is considered successful when it can be shown via analysis that the parts control process is compliant with 3.4.4.A. (LS-71000, Section 5.4.1.1.10)

B. Compliance with 3.4.4.B is considered successful when an analysis is provided which includes a risk assessment, electrical stress analysis, and data delivery on information such as designed/as-built EEE parts, list, construction history, Government and Industry Data Exchange Program (GIDEP) Alerts, part obsolescence, radiation susceptibility, and/or prior history. (LS-71000, Section 5.4.1.1.10)

C. The burn-in test may be accomplished at the component or assembly level, and is specified as:

- 72 hours continuously at room ambient temperature while functioning. The centrifuge chamber will be set to +4 °C; however, the rotor will not be spinning.

- 96 hours continuously at a 35 °C while functioning. The centrifuge chamber will be set to +4 °C; however, the rotor will not be spinning.

Full functional tests shall be performed on the experiment hardware before and after the burn-in test.

All flight assemblies utilizing non-military parts (as specified in Section 3.4.4) shall undergo burn-in testing. (LS-71000, Section 5.4.1.1.10)

4.3.5 Flammability

Payload materials shall be non-flammable or self-extinguishing per the test criteria of NASA-STD-6001, Test 1, Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion. The material shall be evaluated in the worst-case use environment at the worst-case use configuration. When the use of a nonflammable material is not possible, a Material Usage Agreement (MUA) or equivalent shall be submitted to the cognizant NASA center for disposition. If test data does not exist for a material, the experimenter may be asked to provide samples (see NASA-STD-6001, Chapter 4) to a NASA certified test facility Marshall Space Flight Center (MSFC) or White Sands Test Facility (WSTF) for flammability testing). (LS-71000, Section 5.4.1.1.8)

Materials transported or operated in the orbiter cabin, or operated in the ISS air lock during Extravehicular Activity (EVA) preparations, shall be tested and evaluated for flammability in the worst-case use environment of 30% oxygen and 10.2 psia. Materials used in all other habitable areas shall be tested and evaluated in the worst-case use environment of 24.1% oxygen and 15.2 psia. (LS-71000, Section 5.4.1.1.8)

4.3.6 Offgassing

All flight hardware located in habitable areas shall be subjected to test and meet the toxicity offgassing acceptance requirements of NASA-STD-6001, Test 7. (LS-71000, Section 5.4.1.1.9)

4.3.7 Shock Test

Not applicable to RC.

4.3.8 Bench Handling

A bench handling test shall be performed on the qualification unit for all hardware. The bench handling test shall be conducted in accordance with MIL-STD-810, Section 516.4, I3.6, Procedure 6. The test configuration will be specified per TPS.

4.3.9 Payload Mass

The RC shall comply with LS-71014, Mass Properties Control Plan. (LS-71000, Section 5.4.1.1.1)

4.3.10 Electromagnetic Compatibility

The RC shall comply with LS-71016, HRF EMI/EMC Control Plan. (LS-71000, Section 5.4.1.2.1)

4.3.11 Acoustic Noise

The RC shall comply with LS-71011, Acoustic Noise Control and Analysis Plan for Human Research Facility Payloads and Racks. (LS-71000, Section 5.4.1.1.7)

4.3.12 Pre-Delivery Acceptance

The responsible manufacturing parties shall perform a PDA test after the complete fabrication and assembly has been conducted for all Class I deliverable assemblies. This test shall include verification of software interface and operation. The PDA must be completed before hardware certification testing begins. It is a full functional test and inspection that validates that the hardware operates per the design requirements and that it is constructed per released engineering drawings. All PDA tests shall be approved by the hardware's JSC technical monitor and JSC/NT3, as well as the contractor quality engineering (if applicable). The following are standard steps that each PDA test shall contain:

1. Conformance to Drawing. Verify that the hardware conforms to released engineering drawings.

2. No Sharp Edges. Inspect the hardware to verify that there are no sharp edges or corners present.

3. Proper Identifying Markings. Verify that the hardware has the proper part number and serial number (if applicable) on it.

4. Weight and CG. Measurements shall be taken of the as-built configuration per Section 3.2.2.1 of this document.

5. Functional Testing. This is a full functional test and checks all interfaces.

4.3.13 Pre-Installation Acceptance

Payload Integration Agreement (PIA) testing occurs prior to installation in the HRF Rack.

1. Cleanliness. PIA tests shall include verification that surfaces are to the cleanliness level of Section 3.3.1.1.4 of this document.

2. Functional Testing. PIA functional testing checks rack interfaces prior to installation in the HRF Rack.

5.0 PREPARATION FOR SHIPMENT

The RC will be shipped in accordance with WM-3230-001. All shipping rules and regulations are performed and verified by logistics personnel in B421. This requirement is not verifiable and is not the responsibility of the payload developers.

6.0 NOTES

This section contains information of a general or explanatory nature that may be helpful but is not mandatory.

6.1 DEFINITIONS

Qualification Test	Test conducted as part of the certification program to demonstrate that the design and performance requirements can be realized under specified conditions.
Acceptance Test	Formal tests conducted to assure that the end item meets specified requirements. Acceptance tests include performance demonstrations and environmental exposures to screen out manufacturing defects, workmanship errors, incipient failures, and other performance anomalies not readily detectable by normal inspection techniques or through ambient functional tests.
Active Air Exchange	Forced convection between two volumes. For example, forced convection between a subrack payload and the internal volume of an integrated rack, or forced convection between a subrack payload and cabin air.
Continuous Noise Source	A significant noise source that exists for a cumulative total of eight hours or more in any 24-hour period is considered to be a continuous noise source.
Intermittent Noise Source	A significant noise source that exists for a cumulative total of less than eight hours in a 24-hour period is considered to be an intermittent noise source.
On-Orbit Momentary Protrusions	Payload Obstructions that typically would protrude for a very short time or could be readily eliminated by the crew at any time. Momentary protrusions include only the following: drawer/door/cover replacement or closure.
On-Orbit Permanent Protrusion	A payload hardware item that is not ever intended to be removed.
On-Orbit Semi-Permanent Protrusion	A payload hardware item that is typically left in place, but can be removed by the crew with hand operations or standard IVA tools. Example: SIR and ISIS drawer handles, other equipment that does not interfere with crew restraints and mobility aids.

On-Orbit Temporary Protrusion	A payload item that is typically located in the aisle for experiment purposes only. These items should be returned to their stowed configuration when not being used. Example: Front panel mounted equipment.

APPENDIX A

RESERVED

APPENDIX B

ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX

APPENDIX B

ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX

HRD Section	LS-71000 Section	SSP 57000 Section	Requirement	Applicable	GPVP VDS #	Responsibility	Comments
3.2.2.2.2.1A	--	3.1.1.7A	On-Orbit Payload Protrusions - Lateral Extension	✓	ME-059		
3.2.2.2.2.1B	--	3.1.1.7B	On-Orbit Payload Protrusions - Attachment of RMA	✓	ME-059		
3.2.2.2.2.1.1	--	3.1.1.7.1	On-Orbit Permanent Protrusions	✓	ME-059		
3.2.2.2.2.1.2A	--	3.1.1.7.2A	On-Orbit Semi-Permanent Protrusions - SIR and ISIS Drawer Handles	✓	ME-059		
3.2.2.2.2.1.2B	--	3.1.1.7.2B	On-Orbit Semi-Permanent Protrusions - Other	N/A	ME-059		
3.2.2.2.2.1.2C	--	3.1.1.7.2C	On-Orbit Semi-Permanent Protrusions - Removable	✓	ME-059		
3.2.2.2.2.1.3A	--	3.1.1.7.3A	On-Orbit Temporary Protrusions - Envelope	N/A	ME-059		
3.2.2.2.2.1.3B	--	3.1.1.7.3B	On-Orbit Temporary Protrusions - Removal	N/A	ME-059		
3.2.2.2.2.1.4	--	3.1.1.7.4	On-Orbit Momentary Protrusions	✓	ME-059		
3.2.4A	6.4.4.2.6.3	3.12.4.2.8.4	Maintainability - Unique Tools	✓	ME-016		
3.2.4B	6.4.4.3.1	3.12.4.3.1	Maintainability - One-handed Operation	N/A	ME-017		The RC does not contain replaceable connectors
3.2.4C	6.4.4.3.2B	3.12.4.3.2A2	Maintainability - Connector Mate/Demate	✓	ME-018		
3.2.4D	6.4.4.3.2C	3.12.4.3.2B	Maintainability - No Damage to Wiring Connectors	✓	ME-018		
3.2.4E	6.4.4.2.6	3.12.4.2.8	Maintainability - Access to Hardware Items	✓	ME-042		
3.2.4F	6.4.3.1.2B	3.12.3.1.2B	Maintainability - Access to Filters for Replacement/Cleaning	N/A	ME-008		No capture elements
3.2.4G	Maintainability Controls			N/A			
3.2.4H	6.4.3.1.2A	3.12.3.1.2A	Maintainability - Built-in Control	✓	ME-008		
3.2.4.1.1	6.4.10	3.12.10	Payload In-flight Maintenance	✓	ME-003		
3.2.5.1.1.1	6.2.9.1.1	3.9.1.1	Pressure	✓	Safety		
3.2.5.1.1.2A			Operating Temperature	✓	ATT		
3.2.5.1.1.2B	6.2.9.1.2	3.9.1.2	Temperature	✓	QATT		
3.2.5.1.1.3	6.2.9.1.3	3.9.1.3	Humidity	✓	EN-001		Thermal Analysis Report

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX B

ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX (Cont'd)

HRD Section	LS-71000 Section	SSP 57000 Section	Requirement	Applicable	GPVP VDS #	Responsibility	Comments
3.2.5.1.2.3	6.2.9.2.3	3.9.2.3	Chemical Releases	✓	Safety		
3.2.5.1.3.1	6.2.9.3.1	3.9.3.1	Instrument Contained or Generated Ionizing Radiation	N/A	Safety		No ionizing radiation
3.2.5.1.3.3	6.2.9.3.3	3.9.3.3	Single Event Effect (SEE) Ionizing Radiation	✓	EN-004		Not verifiable
3.2.5.1.5A	6.2.1.1.6B	3.1.1.4B	Pressure Rate of Change - On-orbit	✓	ST-003		Structural Analysis
3.2.5.1.5B1	6.2.1.1.6A	3.1.1.2B	Pressure Rate of Change - MPLM	✓	ST-003		Structural Analysis
3.2.5.1.5C	6.2.1.1.6C	3.1.1.4K	Pressure Rate of Change - PFE	N/A	ST-003		
3.2.5.1.5D	6.2.1.1.6D	3.1.1.4M	Pressure Relief Device	✓	TBD		Structural Analysis
3.2.5.1.6A	6.2.1.1.7A	3.1.2.1A	Microgravity - Quasi-steady	N/A	EN-005		No requirement
3.2.5.1.6B	6.2.1.1.7B	3.1.2.2A	Microgravity - Vibratory	N/A	EN-005		No requirement
3.2.5.1.6C	6.2.1.1.7C	3.1.2.3A	Microgravity - Transient	N/A	EN-005		No requirement
3.2.5.2.1A	6.4.3.3.1A	3.12.3.3.1A	Continuous Noise Limits - Sub-Rack Equipment Not Changed Out	N/A	EN-006		Mutually exclusive with 3.2.5.2.1.B
3.2.5.2.1B	6.4.3.3.1B	3.12.3.3.1B	Continuous Noise Limits - Sub-Rack Equipment Changed Out	N/A	EN-006		
3.2.5.2.1C	6.4.3.3.1C	3.12.3.3.1C	Continuous Noise Limits - Independently Operated Equipment	N/A	EN-006		Rack mounted
3.2.5.2.2A	6.4.3.3.2A	3.12.3.3.2	Intermittent Noise Limits - A-weighted SPL Limits	✓	EN-006		65 dBA
3.2.5.2.2B	6.4.3.3.2B	3.12.3.3.2	Intermittent Noise Limits - Cumulative Duration	N/A	EN-006		
3.2.5.3A	6.4.3.4A	3.12.3.4A	Lighting Design - Specularity	N/A	ME-043		Applies to rack only
3.2.5.3B	6.4.3.4B	3.12.3.4B	Lighting Design - Levels	N/A	ME-043		No glovebox operations and Portable Utility Light (PUL) will be used if necessary
3.2.5.3C	6.4.3.4C	3.12.3.4C	Lighting Design - Dimmable	N/A	ME-043		No glovebox operations and PUL will be used if necessary

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX B

ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX (Cont'd)

HRD Section	LS-71000 Section	SSP 57000 Section	Requirement	Applicable	GPVP VDS #	Responsibility	Comments
3.2.5.3D	6.4.3.4D	3.12.3.4D	Lighting Design - Brightness Ratio	N/A	ME-043		No glovebox operations and PUL will be used if necessary
3.2.5.3E	6.4.3.4E	3.12.3.4E	Lighting Design - Utilize ISS PUL	N/A	ME-043		No glovebox operations and PUL will be used if necessary
3.2.5.4	6.2.5.3	3.5.1.11	Instrument Surface Temperature	✓	FD-032		Thermal Analysis
3.2.7.1.1	6.1.1.6.1	3.1.1.6.1	Connector Physical Mate	N/A	EL-007 ME-056		No UIP or UOP interfaces
3.2.7.2.7	6.2.2.8	3.2.4	Electromagnetic Compatibility (EMC)	✓	EL-020		
3.2.7.2.7.1	6.2.2.8.1	3.2.4.1	Electrical Grounding	✓	EL-021		
3.2.7.2.7.2	6.2.2.8.2	3.2.4.2	Electrical Bonding	✓	EL-022		
3.2.7.2.7.3A	6.2.2.8.4	3.2.4.4	Electromagnetic Interference	✓	EL-020		
3.2.7.2.7.3B	6.3.2.4.4	3.2.4.4	Electromagnetic Interference - Alternative Use of RS03PL	✓	EL-020		
3.2.7.2.8A	6.2.2.9	3.2.4.5	ESD ≤ 4000V	E	EL-024		No test or labeling – No accessibility to ESD because gear grounded to rack
3.2.7.2.8B	6.2.2.9	3.2.4.5	ESD between 4000V and 15000V - Labeling EPCE	E	EL-024		No test or labeling
3.2.7.2.8C	6.2.2.9	3.2.4.5	ESD Labeling	E	EL-024		No test or labeling
3.2.7.2.9	6.2.2.12	3.2.4.8	Corona	✓	EL-024		
3.2.7.2.10	6.2.2.8.3	3.2.4.3	Cable/Wire Design and Control Requirements	✓	EL-021		
3.2.7.2.10.1A	6.2.2.7.1A	3.2.3.1B	Wire Derating - Instruments Connected to HRF Rack 28 V Power Outlets	✓	EL-017		
3.2.7.2.10.2	6.2.2.7.2	3.2.3.2B	Exclusive Power Feeds	N/A	EL-018		
3.2.7.2.11	6.2.2.7.3	3.2.3.3	Loss of Power	✓	Safety		
3.2.7.2.12	6.2.2.10	3.2.4.6	AC Magnetic Fields	✓	EL-020		

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX B

ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX (Cont'd)

HRD Section	LS-71000 Section	SSP 57000 Section	Requirement	Applicable	GPVP VDS #	Responsibility	Comments
3.2.7.2.13	6.2.2.11	3.2.4.7	DC Magnetic Fields	✓	EL-020		
3.2.7.3.6.3.2.1.1	6.2.3.6.1	3.3.2.1	Word/Byte Notations	✓	CD-001		
3.2.7.3.6.3.2.1.2	6.2.3.6.2	3.3.2.2	Data Types	✓	CD-001		
3.2.7.3.10.1	6.2.3.10.1	3.3.2.3B	Data Transmissions	N/A	CD-001		Rack handles C&DH
3.2.7.3.10.2A	6.2.3.10.2A	3.3.4.1A	CCSDS Data: Space to Ground	N/A	CD-001		Rack handles C&DH
3.2.7.3.10.2B	6.2.3.10.2B	3.3.4.1B	CCSDS Data: Ground to Space	N/A	CD-001		Rack handles C&DH
3.2.7.3.10.2C	6.2.3.10.2C	3.3.4.1C	CCSDS Data: Instrument to P/L MDM	N/A	CD-001		Rack handles C&DH
3.2.7.3.10.2.1	6.2.3.10.2.1	3.3.4.1.1	CCSDS Data Packets	N/A	CD-001		Rack handles C&DH
3.2.7.3.10.2.1.1	6.2.3.10.2.1.1	3.3.4.1.1.1	CCSDS Primary Header	N/A	CD-001		Rack handles C&DH
3.2.7.3.10.2.1.2A	6.2.3.10.2.1.2A	3.3.4.1.1.2A	CCSDS Secondary Header - Location	N/A	CD-001		Rack handles C&DH
3.2.7.3.10.2.1.2B	6.2.3.10.2.1.2B	3.3.4.1.1.2B	CCSDS Secondary Header - format	N/A	CD-001		Rack handles C&DH
3.2.7.3.10.2.2	6.2.3.10.2.2	3.3.4.1.2	CCSDS Data Field	N/A	CD-003		Rack handles C&DH
3.2.7.3.10.2.3	6.2.3.10.2.3	3.3.4.1.4	CCSDS Application Process Identification Field	N/A	CD-003		Rack handles C&DH
3.2.7.5.1.2A	6.2.5.1.2A	3.5.1.2A	ITCS Fluid Use	N/A	FD-002		Heat exchange to rack air
3.2.7.5.1.2B	6.2.5.1.2B	3.5.1.2B	Rack dependent Instrument Charging	N/A	FD-002		Heat exchange to rack air
3.2.7.5.1.4	6.2.5.1.4	3.5.1.7A	Coolant Maximum Design Pressure	N/A	ST-010		Heat exchange to rack air
3.2.7.5.1.5	6.2.5.1.5	3.5.1.16	Payload Coolant Quantity	N/A	FD-012		Heat exchange to rack air
3.2.7.5.1.6	6.2.5.1.6	3.5.1.8	Fail Safe Design	N/A	FD-031		Heat exchange to rack air
3.2.7.5.1.7	6.2.5.1.7	3.5.1.9	Leakage	N/A	FD-006		Heat exchange to rack air
3.2.7.5.1.8	6.2.5.1.8	3.5.1.10	Quick-Disconnect Air Inclusion	N/A	FD-007		Heat exchange to rack air
3.2.7.6.2.1A	6.2.6.2.1A	3.6.1.2A	VES Input Pressure Limit - Rack-to-Station Interface	N/A	FD-015		No VES interface
3.2.7.6.2.1B	6.2.6.2.1B	3.6.1.2B	VES Input Pressure Limit - Maximum Design Pressure	N/A	FD-015		No VES interface
3.2.7.6.2.1C	6.2.6.2.1C	3.6.1.2C	VES Input Pressure Limit - Two Failure Tolerance	N/A	FD-015		No VES interface
3.2.7.6.2.2	6.2.6.2.2	3.6.1.3	VES Input Temperature Limit	N/A	FD-016		No VES interface

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX B

ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX (Cont'd)

HRD Section	LS-71000 Section	SSP 57000 Section	Requirement	Applicable	GPVP VDS #	Responsibility	Comments
3.2.7.6.2.3	6.2.6.2.3	3.6.1.4	VES Input Dewpoint Limit	N/A	FD-017		No VES interface
3.2.7.6.2.4A	6.2.6.2.4A	3.6.1.5A	VES Acceptable Exhaust Gases - Compatibility	N/A	FD-018		No VES interface
3.2.7.6.2.4B	6.2.6.2.4B	3.6.1.5B	VES Acceptable Exhaust Gases - Non-reactivity	N/A	FD-018		No VES interface
3.2.7.6.2.4C	6.2.6.2.4C	3.6.1.5C	VES Acceptable Exhaust Gases - Gas Removal	N/A	FD-018		No VES interface
3.2.7.6.2.4D	6.2.6.2.4D	3.6.1.5D	VES Acceptable Exhaust Gases - Particulate Removal	N/A	FD-018		No VES interface
3.2.7.6.2.5	6.2.6.2.5	3.6.1.5.2	VES External Contamination Control	N/A	FD-019		No VES interface
3.2.7.6.2.6A	6.2.6.2.6A	3.6.1.5.3A	VES Incompatible Gases - Containment	N/A	FD-020		No VES interface
3.2.7.6.2.6B	6.2.6.2.6B	3.6.1.5.3B	VES Incompatible Gases - Containment Hardware	N/A	FD-020		No VES interface
3.2.7.6.3.1A	6.2.6.3.1A	3.6.2.2A	VRS Input Pressure Limit - Vented VRS Gases	N/A	FD-022		No VRS interface
3.2.7.6.3.1B	6.2.6.3.1B	3.6.2.2B	VRS Input Pressure Limit - Maximum Design Pressure	N/A	FD-022		No VRS interface
3.2.7.6.3.1C	6.2.6.3.1C	3.6.2.2C	VRS Input Pressure Limit - Two Failure Tolerance	N/A	FD-022		No VRS interface
3.2.7.6.3.2	6.2.6.3.2	3.6.2.3	VRS Through-Put Limit	N/A	FD-023		No VRS interface
3.2.7.7.1.2	6.2.7.1.2	3.7.1.1	Nitrogen Interface Control	N/A	FD-024		No gas interface
3.2.7.7.1.3	6.2.7.1.3	3.7.1.2	Nitrogen Interface MDP	N/A	FD-025		No gas interface
3.2.7.7.1.4	6.2.7.1.4	3.7.1.3	Nitrogen Interface Temperature	N/A	FD-026		No gas interface
3.2.7.7.1.5	6.2.7.1.5	3.7.1.4	Nitrogen Leakage	N/A	FD-027		No gas interface
3.2.7.7.2	6.2.7.2	3.7.5	Pressurized Gas Systems	✓	FD-028		
3.2.7.7.3	6.2.7.3	3.7.6	Manual Valves	N/A	ME-048		No manual valves
3.2.7.8.1.1	6.2.8.1.1	3.8.1.1, 3.1.1.6.1	ISS Potable Water Interface Connection	N/A	ME-056		No use for potable water
3.2.7.8.1.2	6.2.8.1.2	3.8.1.2	Potable Water Interface Pressure	N/A	FD-029		No use for potable water
3.2.7.8.1.3A	6.2.8.1.3A	3.8.1.3A	Potable Water Use - Not Returned to Cabin Air as Humidity	N/A	FD-030		No use for potable water
3.2.7.8.1.3B	6.2.8.1.3B	3.8.1.3B	Potable Water Use - Total Use	N/A	FD-030		No use for potable water

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX B

ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX (Cont'd)

HRD Section	LS-71000 Section	SSP 57000 Section	Requirement	Applicable	GPVP VDS #	Responsibility	Comments
3.2.7.8.2	6.2.8.2	3.8.2	Fluid System Servicer	N/A	ME-049		No interface
3.2.7.9.1	6.2.10.1	3.10.1	Fire Prevention	✓	Safety		
3.2.7.9.2.1.1		3.10.2.2.1	Parameter Monitoring Use	N/A	ME-054		Uses rack smoke detector
3.2.7.9.2.1.2A		3.10.2.2.2.1A	Parameter Monitoring in Subrack	N/A	CD-020		Uses rack smoke detector
3.2.7.9.2.1.2B		3.10.2.2.2.1A	Parameter Monitoring in Subrack	N/A	CD-020		Uses rack smoke detector
3.2.7.9.3.1A	6.2.10.2A	3.10.3.1A	PFE - Small Access Port	N/A	ME-055		Uses rack PFE port
3.2.7.9.3.1B	6.2.10.2B	3.10.3.1B	PFE - Large Access Port	N/A	ME-055		Uses rack PFE port
3.2.7.9.3.2	6.2.10.3	3.10.3.2	Fire Suppression Access Port Accessibility	N/A	ME-055		Uses rack PFE port
3.2.7.9.3.3	6.2.10.4	3.10.3.3	Fire Suppressant Distribution	N/A	ME-055		Uses rack PFE port
3.2.7.9.4	6.2.10.5	3.10.4A	Labeling	N/A	ME-055		Uses rack PFE port
3.3.1.1.1	6.2.11.1	3.11.1	Materials and Parts use and Selection	✓	Safety		Material Cert Report
3.3.1.1.2	6.2.11.2	3.11.1.1	Commercial Parts	✓	Safety		Material Cert Report
3.3.1.1.3A	6.2.11.3A	3.11.2A	Fluids - General Requirements	N/A	MP-001		No fluids interface
3.3.1.1.3B	6.2.11.3B	3.11.2B	Fluids - Cleanliness Levels	N/A	MP-001		No fluids interface
3.3.1.1.3C	6.2.11.3C	3.11.2C	Fluids - Instrument Internal Materials	N/A	MP-001		No fluids interface
3.3.1.1.4	6.2.11.4	3.11.3	Cleanliness	✓	MP-002		
3.3.1.1.5	6.2.11.5	3.11.4	Fungus Resistant Material	✓	MP-003		
3.3.1.2	6.4.9.2	3.12.9.2	Sharp Edges and Corner Protection	✓	Safety		
3.3.1.3	6.4.9.3	3.12.9.3	Holes	✓	ME-007		
3.3.1.4	6.4.9.4	3.12.9.4	Latches	✓	ME-027		
3.3.1.5	6.4.9.5	3.12.9.5	Screws and Bolts	✓	ME-026		
3.3.1.6	6.4.9.6	3.12.9.6	Securing Pins	N/A	ME-053		No securing pins
3.3.1.7	6.4.9.7	3.12.9.7	Levers, Cranks, Hooks, and Controls	✓	ME-053		
3.3.1.8	6.4.9.8	3.12.9.8	Burrs	✓	ME-053		
3.3.1.9A	6.4.9.9A	3.12.9.9A	Locking Wires	✓	ST-009		

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX B

ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX (Cont'd)

HRD Section	LS-71000 Section	SSP 57000 Section	Requirement	Applicable	GPVP VDS #	Responsibility	Comments
3.3.1.9B	6.4.9.9B	3.12.9.9B	Locking Wires	✓	ST-009		
3.3.2.1	6.4.7	3.12.7	Equipment Identification	✓	ME-057		
3.3.5.1	6.2.2.14	3.2.5.1	Electrical Safety	✓	Safety		
3.3.5.1.1	6.2.2.14.1.2	3.2.5.1.2	Safety - Critical Circuits Redundancy	N/A	Safety		No safety critical circuits
3.3.5.1.2	6.2.2.13	3.2.4.10	EMI Susceptibility for Safety-Critical Circuits	N/A	EL-019		No safety critical circuits
3.3.5.1.3A	6.2.2.14.1.1	3.2.5.1.1	Mating/Demating of Powered Connectors	N/A	Safety		
3.3.5.1.4A	6.2.2.15A	3.2.5.3A	Power Switches/Controls - Open Supply Circuit Conductors	✓	EL-029		
3.3.5.1.4B	6.2.2.15B	3.2.5.3B	Power Switches/Controls - Power-off Markings/Indications	✓	EL-029		
3.3.5.1.4C	6.2.2.15C	3.2.5.3C	Power Switches/Controls - Supply Circuit not Completely Disconnected	✓	EL-029		
3.3.5.1.5A	6.2.2.16A	3.2.5.4A	GFCI - Output Voltages > 30 V rms	N/A	EL-030		No power outlets which exceed 32 volts rms or dc maximum
3.3.5.1.5B	6.2.2.16B	3.2.5.4B	GFCI - DC Detection Independent of Safety Wire	N/A	EL-030		No GFCI required
3.3.5.1.5C	6.2.2.16C	3.2.5.4C	GFCI - AC Detection Dependent on Safety Wire	N/A	EL-030		No GFCI required
3.3.5.1.5D	6.2.2.16D	3.2.5.4D	GFCI - Equipment Generating Internal Voltages > 30 V rms	N/A	EL-030		No credible fault path
3.3.5.1.5E	6.2.2.16E	3.2.5.4E	GFCI - Trip Current	N/A	EL-030		No GFCI required
3.3.5.1.5F	6.2.2.16F	3.2.5.4F	GFCI - Power Removal Time	N/A	EL-030		No GFCI required
3.3.5.1.5G	6.2.2.16G	3.2.5.4G	GFCI - On-Orbit Testing	N/A	EL-030		No GFCI required
3.3.5.1.6A	6.2.2.17A	3.2.5.5A	Portable Equipment/Power Cords - Non-battery Powered Portable Equipment	N/A	EL-031		Not portable equipment
3.3.5.1.6B	6.2.2.17B	3.2.5.5B	Portable Equipment/Power Cords - Fault Currents	N/A	EL-031		Not portable equipment
3.3.6.1	6.4.3.1.1	3.12.3.1.1	Closures or Covers Design Requirements	✓	ME-007		
3.3.6.3	6.4.2.3	3.12.2.3	Full Size Range Accommodation	✓	ME-006		

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX B

ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX (Cont'd)

HRD Section	LS-71000 Section	SSP 57000 Section	Requirement	Applicable	GPVP VDS #	Responsibility	Comments
3.3.6.4A	6.4.1.1A	3.12.1A1	Grip Strength	✓	ST-005		
3.3.6.4B	6.4.1.1B	3.12.1A2	Linear Forces	✓	ST-005		
3.3.6.4C	6.4.1.1C	3.12.1A3	Torque	✓	ST-005		
3.3.6.5	6.4.1.2	3.12.1B	Maintenance Operations	✓	ST-005		
3.3.6.6	6.4.2.1	3.12.2.1	Adequate Clearance	N/A	ME-021		Not a rack
3.3.6.7A	6.4.2.2A	3.12.2.2A	Accessibility - Geometric Arrangement	✓	ME-021		
3.3.6.7B	6.4.2.2B	3.12.2.2B	Accessibility - Access Openings for Fingers	✓	ME-021		
3.3.6.8	6.4.3.1.3	3.12.3.1.5	One-Handed Operation	✓	ME-009		
3.3.6.9	6.4.3.2.1	3.12.3.2.1	Continuous/Incidental Contact - High Temperature	✓	Safety		
3.3.6.10	6.4.3.2.2	3.12.3.2.2	Continuous/Incidental Contact - Low Temperature	✓	Safety		
3.3.6.11a	6.4.4.2.1	3.12.4.2.1	Equipment Mounting	✓	ME-011		
3.3.6.12A	6.4.4.2.2A	3.12.4.2.2	Drawers and Hinged Panels - for routine checkout of P/L ORUs	✓	ME-012		
3.3.6.12B	6.4.4.2.2B	3.12.4.2.2	Drawers and Hinged Panels - remain open without manual support	✓	ME-012		
3.3.6.13	6.4.4.2.3	3.12.4.2.5	Alignment	✓	ME-013		
3.3.6.14	6.4.4.2.4	3.12.4.2.6	Slide-Out Stops	✓	ME-002		
3.3.6.15	6.4.4.2.5	3.12.4.2.7	Push-Pull Force	✓	ST-006		
3.3.6.16A	6.4.4.2.6.1A	3.12.4.2.8.1A	Covers - sliding or hinged cap or door	✓	ME-007		
3.3.6.16B	6.4.4.2.6.1B	3.12.4.2.8.1B	Covers - quick-opening cover plate	✓	ME-007		
3.3.6.17	6.4.4.2.6.2	3.12.4.2.8.2	Self-Supporting Covers	✓	ME-007		
3.3.6.18	6.4.4.3.2A	3.12.4.3.2A1	Accessibility	✓	ME-018		
3.3.6.19A	6.4.4.3.3A	3.12.4.3.3A	Ease of Disconnect - Nominal Operations	N/A	ME-017		
3.3.6.19B	6.4.4.3.3B	3.12.4.3.3B	Ease of Disconnect - ORU Replacement Operations	N/A	ME-017		

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX B

ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX (Cont'd)

HRD Section	LS-71000 Section	SSP 57000 Section	Requirement	Applicable	GPVP VDS #	Responsibility	Comments
3.3.6.20	6.4.4.3.4	3.12.4.3.4	Indication of Pressure/Flow	N/A	ME-050		No lines designed to be disconnected under pressure
3.3.6.21	6.4.4.3.5	3.12.4.3.5	Self Locking	✓	ME-017		
3.3.6.22A	6.4.4.3.6A	3.12.4.3.6A	Connector Arrangement - Space between Connectors and Adjacent Obstructions	N/A	ME-018		
3.3.6.22B	6.4.4.3.6B	3.12.4.3.6B	Connector Arrangement - Space between Connectors in a Row	N/A	ME-018		
3.3.6.23	6.4.4.3.7	3.12.4.3.7	Arc Containment	N/A	EL-026		
3.3.6.24	6.4.4.3.8	3.12.4.3.8	Connector Protection	N/A	ME-019		
3.3.6.25	6.4.4.3.9	3.12.4.3.9	Connector Shape	N/A	ME-019		
3.3.6.26	6.4.4.3.10	3.12.4.3.10	Fluid and Gas Line Connectors	N/A	FD-001		No fluid/gas connectors designed to be mated/ demated on-orbit
3.3.6.27	6.4.4.3.11A	3.12.4.3.11A	Alignment Marks or Guide Pins	✓	ME-020		
3.3.6.28A	6.4.4.3.12A	3.12.4.3.12A	Coding - Unique to Connection	N/A	ME-020		
3.3.6.28B	6.4.4.3.12B	3.12.4.3.12B	Coding - Visible	N/A	ME-020		
3.3.6.29	6.4.4.3.13	3.12.4.3.13	Pin Identification	N/A	EL-007		
3.3.6.30	6.4.4.3.14	3.12.4.3.14	Orientation	N/A	ME-020		
3.3.6.31A	6.4.4.3.15A	3.12.4.3.15A	Hose/Cable Restraints - Loose Ends	N/A	ME-022		Not a rack
3.3.6.31B	6.4.4.3.15B	3.12.4.3.15B	Hose/Cable Restraints - Clamps	N/A	ME-022		Not a rack
3.3.6.31D	6.4.4.3.15D	3.12.4.3.15D	Hose/Cable Restraints - Loose Cables	N/A	ME-022		No loose cables
3.3.6.32	6.4.4.4.1	3.12.4.4.1	Non-Threaded Fasteners Status Indication	✓	ME-023		
3.3.6.33	6.4.4.4.2	3.12.4.4.2	Mounting Bolt/Fastener Spacing	✓	ME-024		
3.3.6.34	6.4.4.4.3	3.12.4.4.4A	Multiple Fasteners	✓	ME-025		
3.3.6.35	6.4.4.4.4	3.12.4.4.5	Captive Fasteners	e	ME-026		Fasteners are designed to be removed and stowed.

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX B

ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX (Cont'd)

HRD Section	LS-71000 Section	SSP 57000 Section	Requirement	Applicable	GPVP VDS #	Responsibility	Comments
3.3.6.36A	6.4.4.4.5A	3.12.4.4.6A	Quick Release Fasteners - One turn max	✓	ME-026		
3.3.6.36B	6.4.4.4.5B	3.12.4.4.6B	Quick Release Fasteners - Positive Locking	✓	ME-026		
3.3.6.37	6.4.4.4.6	3.12.4.4.7	Threaded Fasteners	✓	ME-026		
3.3.6.38A	6.4.4.4.7A	3.12.4.4.8A	Over Center Latches - Nonself-latching	✓	ME-027		
3.3.6.38B	6.4.4.4.7B	3.12.4.4.8B	Over Center Latches - Latch Lock	✓	ME-027		
3.3.6.38C	6.4.4.4.7C	3.12.4.4.8C	Over Center Latches - Latch Handles	✓	ME-027		
3.3.6.39	6.4.4.4.8	3.12.4.4.9	Winghead Fasteners	✓	ME-026		
3.3.6.40A	6.4.4.4.9A	3.12.4.4.11A	Fastener Head Type - On-Orbit Crew Actuation	✓	ME-028		
3.3.6.40B	6.4.4.4.9B	3.12.4.4.11B	Fastener Head Type - Smooth Surface	✓	ME-028		
3.3.6.40C	6.4.4.4.9C	3.12.4.4.11C	Fastener Head Type - Slotted Fasteners	✓	ME-028		
3.3.6.41	6.4.4.4.10	3.12.4.4.12	One-Handed Actuation	✓	ME-029		
3.3.6.42			Reserved				
3.3.6.43	6.4.4.4.12	3.12.4.4.14	Access Holes	✓	ME-024		
3.3.6.44	6.4.5.1	3.12.5.1	Controls Spacing Design Requirements	✓	ME-030		
3.3.6.45.1A	6.4.5.2.1A	3.12.5.2.1A	Protective Methods - Location/Orientation	✓	ME-031		
3.3.6.45.1B	6.4.5.2.1B	3.12.5.2.1B	Protective Methods - Recess/Shielding	✓	ME-031		
3.3.6.45.1C	6.4.5.2.1C	3.12.5.2.1C	Protective Methods - Cover/Guard, No Safety or Lock Wire	✓	ME-031		
3.3.6.45.1D	6.4.5.2.1D	3.12.5.2.1D	Protective Methods - Obscuration by Cover Guards	✓	ME-031		
3.3.6.45.1E	6.4.5.2.1E	3.12.5.2.1E	Protective Methods - Interlocks	✓	ME-031		
3.3.6.45.1F	6.4.5.2.1F	3.12.5.2.1F	Protective Methods - Resistance	✓	ME-031		
3.3.6.45.1G	6.4.5.2.1G	3.12.5.2.1G	Protective Methods - Position Locks for Sequencing	✓	ME-031		
3.3.6.45.2	6.4.5.2.2	3.12.5.2.2	Noninterference	✓	ME-030		
3.3.6.45.4	6.4.5.2.4	3.12.5.2.4	Barrier Guards	✓	ME-030		
3.3.6.45.5	6.4.5.2.5	3.12.5.2.5	Recessed Switch Protection	✓	ME-031		

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX B

ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX (Cont'd)

HRD Section	LS-71000 Section	SSP 57000 Section	Requirement	Applicable	GPVP VDS #	Responsibility	Comments
3.3.6.46	6.4.5.2.7	3.12.5.2.7	Position Indication	✓	ME-032		
3.3.6.47	6.4.5.2.8	3.12.5.2.8	Hidden Controls	✓	ME-031		
3.3.6.48	6.4.5.2.9	3.12.5.2.9	Hand Controllers	N/A	ME-031		No hand controllers
3.3.6.49A	6.4.5.3A	3.12.5.3A	Valve Controls - Low-Torque Valves	N/A	ME-033		No valve controls
3.3.6.49B	6.4.5.3B	3.12.5.3B	Valve Controls - Intermediate-Torque Valves	N/A	ME-033		No valve controls
3.3.6.49C	6.4.5.3C	3.12.5.3C	Valve Controls - High-Torque Valves	N/A	ME-033		No valve controls
3.3.6.49D	6.4.5.3D	3.12.5.3D	Valve Controls - Handle Dimensions	N/A	ME-033		No valve controls
3.3.6.49E	6.4.5.3E	3.12.5.3E	Valve Controls - Rotary Valve Controls	N/A	ME-033		No valve controls
3.3.6.50	6.4.5.4	3.12.5.4	Toggle Switches	✓	ME-034		
3.3.6.51	6.4.6	3.12.6	Restraints and Mobility Aids	✓	ME-035		
3.3.6.51.1A	6.4.6.1A	3.12.6.1A	Stowage Drawer Contents - Restraints	N/A	ME-036		No stowage drawer
3.3.6.51.1B	6.4.6.1B	3.12.6.1B	Stowage Drawer Contents - Restraints	N/A	ME-036		No stowage drawer
3.3.6.51.1C	6.4.6.1C	3.12.6.1C	Stowage Drawer Contents - Restraints	N/A	ME-036		No stowage drawer
3.3.6.51.2A	6.4.6.2A	3.12.6.2A	Stowage and Equipment Drawers/Trays	N/A	ME-027		No stowage drawer
3.3.6.51.2B	6.4.6.2B	3.12.6.2B	Stowage and Equipment Drawers/Trays	N/A	ME-027		No stowage drawer
3.3.6.51.3	6.4.6.3	3.12.6.3	Captive Parts	✓	ME-036		
3.3.6.51.4.1	6.4.6.4.1	3.12.6.4.1	Handles and Restraints	N/A	ME-037		No transportable items
3.3.6.51.4.2	6.4.6.4.2	3.12.6.4.3	Handle Location/Front Access	N/A	ME-037		No transportable items
3.3.6.51.4.3	6.4.6.4.3	3.12.6.4.4	Handle Dimensions	N/A	ME-037		No transportable items
3.3.6.51.4.4A	6.4.6.4.4A	3.12.6.4.5A	Non-Fixed Handles Design Requirements - Stop Position	N/A	ME-037		No transportable items
3.3.6.51.4.4B	6.4.6.4.4B	3.12.6.4.5B	Non-Fixed Handles Design Requirements - One Hand Use	N/A	ME-037		No transportable items
3.3.6.51.4.4C	6.4.6.4.4C	3.12.6.4.5C	Non-Fixed Handles Design Requirements - Locked/Unlocked Indication	N/A	ME-037		No transportable items

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

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ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX (Cont'd)

HRD Section	LS-71000 Section	SSP 57000 Section	Requirement	Applicable	GPVP VDS #	Responsibility	Comments
3.3.6.52B	6.4.9.1B	3.12.9.1B	Electrical Hazards - Exposure hazard exceeds threshold for shock	✓	EL-041		
3.3.6.52C	6.4.9.1C	3.12.9.1C	Electrical Hazards - Exposure hazard exceeds threshold for shock and threshold of let-go profile	✓	EL-041		
3.3.6.52D	6.4.9.1D	3.12.9.1D	Electrical Hazards - Two dependent controls provided	✓	EL-041		
3.3.6.52E	6.4.9.1E	3.12.9.1E	Electrical Hazards - Three independent hazard controls	✓	EL-041		
3.3.6.52.1A	6.4.9.1.1A	3.12.9.1.1	Mismatched - Reversed Connection	N/A	ME-019		The RC does not have any connectors that require crew action.
3.3.6.52.1B	6.4.9.1.1B	3.12.9.1.1	Mismatched - Blind Connections	N/A	ME-019		
3.3.6.52.1C	6.4.9.1.1C	3.12.9.1.1	Mismatched - Mismating	N/A	ME-019		
3.3.6.52.1D	6.4.9.1.1D	3.12.9.1.1	Mismatched - Minimizing Equipment Risk	N/A	ME-019		
3.3.6.52.2.1	6.4.9.1.2.1	3.12.9.1.4.1	Device Accessibility	✓	EL-013		
3.3.6.52.2.2	6.4.9.1.2.2	3.12.9.1.4.2	Extractor - Type Fuse Holder	✓	EL-013		
3.3.6.52.2.3	6.4.9.1.2.3	3.12.9.1.4.3	Overload Protection Location	✓	EL-013		
3.3.6.52.2.4	6.4.9.1.2.4	3.12.9.1.4.4	Overload Protection Identification	✓	EL-013		
3.3.6.52.2.5	6.4.9.1.2.5	3.12.9.1.4.5	Automatic Restart Protection	✓	EL-013		
3.3.6.53A	6.4.9.10A	3.12.9.10A	Audio Displays - False Alarms	N/A	ME-044		No audio devices
3.3.6.53B	6.4.9.10C	3.12.9.10C	Audio Displays - Operability Testing	N/A	ME-044		No audio devices
3.3.6.53C	6.4.9.10D	3.12.9.10D	Audio Displays - Manual Disable	N/A	ME-044		No audio devices
3.3.6.54	6.4.9.11	3.12.9.12	Egress	✓	Safety		
3.3.8.1.1A	6.2.1.1.4A	3.1.1.3B	Structural Design Requirements - Positive Safety Margins for On-orbit Loads	✓			Structural Analysis
3.3.8.1.1B	6.2.1.1.4B	3.1.1.3D	Structural Design Requirements - Crew Induced Load Requirements	✓	ST-002		Structural Analysis

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX B

ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX (Cont'd)

HRD Section	LS-71000 Section	SSP 57000 Section	Requirement	Applicable	GPVP VDS #	Responsibility	Comments
3.3.8.1.2	6.2.1.1.1	3.1.1.5A	Safety Critical Structures Requirements	✓	ST-001 ST-002 ST-003 ST-004 ST-008 ST-009 ST-010		
3.3.8.1.4A	6.2.1.1.3A	3.1.1.3E	Launch and Landing Loads - Random Vibration	✓	ST-001		
3.3.8.1.4B	6.2.1.1.3B	3.1.1.3F	Launch and Landing Loads - Load Factors	✓	ST-001		

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX C

FUNCTIONAL PERFORMANCE VERIFICATION MATRIX

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HRD Section	LS-71000 Section	Requirement	Applicable	Method	Procedure	Verification Document	Comments
3.2.1.1.1		Centrifugation	✓	A	PDA		
3.2.1.1.2A		Timed Centrifugation	✓	D	PDA		
3.2.1.1.2B		Timed Centrifugation	✓	D	PDA		
3.2.1.1.2C		Timed Centrifugation	✓	D	PDA		
3.2.1.1.3A		Programmable Force	✓	D	PDA		
3.2.1.1.3B		Programmable Force	✓	D	PDA		
3.2.1.1.4A		Sample Sizes	✓	D	PDA		
3.2.1.1.4B		Sample Sizes	✓	D	PDA		
3.2.1.1.5		Programmable Protocols	✓	D	PDA		
3.2.1.1.6		Visual Alert	✓	T	PDA		
3.2.1.1.7		Emergency Stop	✓	D	PDA		
3.2.1.1.8		Unbalanced Conditions	✓	T, D	PDA		
3.2.1.1.9A		Refrigeration	✓	T	PDA		
3.2.1.1.9B		Refrigeration	✓	D	PDA		
3.2.1.1.10		Controlled Angular Acceleration/Deceleration	✓	D	PDA		
3.2.1.1.11A		Displays	✓	D	PDA		
3.2.1.1.11B		Displays	✓	D	PDA		
3.2.1.1.12		Data Monitoring	✓	T	PDA		
3.2.1.1.12.1A		Freon Pressures	✓	T	PDA		
3.2.1.1.12.1B		Freon Pressures	✓	T	PDA		
3.2.1.1.12.2		Evaporator Temperature	✓	T	PDA		
3.2.1.1.12.3		Chamber Temperature	✓	T	PDA		
3.2.1.1.12.4		Drawer Temperature	✓	T	PDA		
3.2.1.1.12.5		Motor Temperature	✓	T	PDA		
3.2.1.1.12.6		Input Current	✓	T	PDA		

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX C

FUNCTIONAL PERFORMANCE VERIFICATION MATRIX (Cont'd)

HRD Section	LS-71000 Section	Requirement	Applicable	Method	Procedure	Verification Document	Comments
3.2.2.1		Mass Properties	✓	T	PDA		
3.2.2.1.1	6.2.1.2.4	HRF Rack Mounted SIR Drawer Center of Gravity Constraints	✓	T			S683-34510 A
3.2.3A	7.1.2	Reliability, Quality, and Non-Conformance Reporting	✓	A			
3.2.3B	7.3.1	Reliability, Quality, and Non-Conformance Reporting	✓	A			
3.2.3C1	7.3.2.1	Reliability, Quality, and Non-Conformance Reporting	✓	A			
3.2.3C2	7.3.2.2	Reliability, Quality, and Non-Conformance Reporting	✓	A	NT1-CWI-003		
3.2.3C3	7.3.2.3	Reliability, Quality, and Non-Conformance Reporting	✓	A	NT1-CWI-003		
3.2.3C4	7.3.2.4	Reliability, Quality, and Non-Conformance Reporting	✓	A			
3.2.3.1		Failure Propagation	✓	A			Phase III Safety Review
3.2.3.2		Useful Life	✓	A			R&M Report
3.2.5.1.5B(2)	6.3.1.2A	Pressure Rate of Change - Carrier (Orbiter)	N/A				
3.2.6.1	6.3.1.3	Launch and Landing	N/A				
3.2.7.1.2.1	6.2.1.2.1	Dimensional Tolerances	✓	A			Review of drwgs.
3.2.7.1.2.2	6.2.1.2.2	SIR Drawer Structural/Mechanical Interfaces	✓				S683-34510 A
3.2.7.2.1.1	6.2.2.1.1	SIR Drawer Power Connectors	✓	A			Review of drwgs.
3.2.7.2.1.2	6.2.2.1.2	Rack connector panel J1 Power Connector	N/A				S683-34510 A
3.2.7.2.2.1	6.2.2.2.1	Steady - State Operating Voltage	✓	T, A			S683-34510 A
3.2.7.2.2.2	6.2.2.2.2	Transient Operating Voltage Envelope	✓	T, A			S683-34510 A
3.2.7.2.2.3A	6.2.2.2.3A	Ripple Voltage/Noise Characteristics -	✓	T, A			S683-34510 A

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX C

FUNCTIONAL PERFORMANCE VERIFICATION MATRIX (Cont'd)

HRD Section	LS-71000 Section	Requirement	Applicable	Method	Procedure	Verification Document	Comments
		Peak to Peak					
3.2.7.2.2.3B	6.2.2.2.3B	Ripple Voltage/Noise Characteristics - Spectrum	✓	T, A			S683-34510 A
3.2.7.2.3	6.2.2.3	Maximum Current Limit	✓	T, A			S683-34510 A
3.2.7.2.4	6.2.2.4	Reverse Current	✓	T, A			S683-34510 A
3.2.7.2.5	6.2.2.5	Reverse Energy	✓	T, A			S683-34510 A
3.2.7.2.6	6.2.2.6	Capacitive Loads	✓	T, A			S683-34510 A
3.2.7.2.10.1B	6.2.2.7.1B	Wire Derating - Basis	✓	A			S683-34510 A
3.2.7.3.1.1	6.2.3.1.1	SIR Drawer Data Connectors	✓	A			Review of drwgs.
3.2.7.3.1.2	6.2.3.1.2	HRF Rack connector Panel J2 Connector	N/A				S683-34510 A
3.2.7.3.2	6.2.3.2	HRF Ethernet Interfaces	✓	A, T			S683-34510 A
3.2.7.3.3	6.2.3.3	HRF TIA/EIA-422 Interfaces	N/A				S683-34510 A
3.2.7.3.4	6.2.3.4	HRF Bi-Directional Discretes Interfaces	N/A				S683-34510 A
3.2.7.3.5	6.2.3.5	HRF Analog Interfaces	✓	A, T			
3.2.7.3.6.2		Modes	✓				
3.2.7.3.6.3.1A		CSCI Functional and Performance Requirements	✓	A, T	SWTP		
3.2.7.3.6.3.1B		CSCI Functional and Performance Requirements	✓	A, T	SWTP		
3.2.7.3.6.3.1C		CSCI Functional and Performance Requirements	✓	A, T	SWTP		
3.2.7.3.6.3.1D		CSCI Functional and Performance Requirements	✓	A, T	SWTP		
3.2.7.3.6.3.1E		CSCI Functional and Performance Requirements	✓	A, T	SWTP		

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX C

FUNCTIONAL PERFORMANCE VERIFICATION MATRIX (Cont'd)

HRD Section	LS-71000 Section	Requirement	Applicable	Method	Procedure	Verification Document	Comments
3.2.7.3.6.3.2.1.3		ISS C&DH Services Through the HRF RIC	✓	A, T	SWTP		
3.2.7.3.6.3.6		Software Safety Requirements	✓	A, T	SWTP		
3.2.7.3.6.3.8		CSCI Environment Requirements	✓	A, T	SWTP		
3.2.7.3.6.3.9A	6.2.3.7C	Software Quality Factors	✓	A, T	SWTP		
3.2.7.3.6.3.9B		Software Quality Factors	✓	A, T	SWTP		
3.2.7.4.1.1	6.2.4.1.1	Standard Interface Rack Drawer Video Interface	N/A				S683-34510 A
3.2.7.4.1.2	6.2.4.1.2	Rack Connector Panel Interface	N/A				S683-34510 A
3.2.7.4.2	6.2.4.2	HRF Rack Video Interface Characteristics	N/A				No video required. S683-34510 A
3.2.7.5.1.1	6.2.5.1.1	HRF Rack Moderate Temperature Loop (MTL) Interface Connectors	N/A				No direct MTL interface
3.2.7.5.1.3	6.2.5.1.3	MTL Interface Maximum Heat Load	N/A				S683-34510 A
3.2.7.5.2.1	6.2.5.2.1	Heat Exchanger interface Maximum Heat Load	✓	A			Thermal Analysis
3.2.7.5.2.2A	6.2.5.2.2A	Fan Hardware	✓	A			HRF ED-003, review of drwg.
3.2.7.5.2.2B	6.2.5.2.2B	Fan Location	✓				HRF ED-003, review of drwg.
3.2.7.5.2.2C	6.2.5.2.2C	Vibration Isolation	✓				HRF ED-003, review of drwg.
3.2.7.5.2.2D	6.2.5.2.2D	Fan Mounting	✓				HRF ED-003, review of drwg.
3.2.7.5.2.2E	6.2.5.2.2E	Fan Operating Voltage	✓				HRF ED-003, review of drwg.
3.2.7.5.2.2F	6.2.5.2.2F	Fan Speed Controller	✓				HRF ED-003, review of drwg.
3.2.7.6.1	6.2.6.1	HRF Vacuum Interface Connectors	N/A				No vacuum interface S683-34510 A
3.2.7.7.1.1	6.2.7.1.1	HRF Rack Nitrogen Interface Connectors	N/A				No nitrogen interface S683-34510 A
3.3.1.10		Fracture/Fatigue	✓	A			Structural Analysis
3.3.1.11		Thread Locking Adhesive	✓	A			review of drwg.

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX C

FUNCTIONAL PERFORMANCE VERIFICATION MATRIX (Cont'd)

HRD Section	LS-71000 Section	Requirement	Applicable	Method	Procedure	Verification Document	Comments
3.3.3	7.3.1	Workmanship	✓	T	QAVT, AVT		
3.3.5.1.3B		Mating/Demating of Powered Connectors	✓	N/A			
3.3.6.2.1A	6.4.3.5.1	Interior Color - Rack Mounted Equipment - Front Panel Color	✓	A			HRF ED-001A, review of drwg.
3.3.6.2.1B	6.4.3.5.1	Interior Color - Rack Mounted Equipment - Front Panel Finish	N/A				HRF ED-001A
3.3.6.2.1C	6.4.3.5.1	Interior Color - Rack Mounted Equipment - Latches	N/A				HRF ED-001A
3.3.6.2.2A	6.4.3.5.2A	Interior Color - Stowed/Deployable Equipment - COTS	✓	A			HRF ED-001A, all stowed hardware is COTS
3.3.6.2.2B	6.4.3.5.2B	Interior Color - Stowed/Deployable Equipment - Repackaged	✓	A			HRF ED-001A, all stowed hardware is COTS
3.3.6.2.3	6.4.3.5.3	Soft Goods - Color	N/A				HRF ED-001A
3.3.8.1.3	6.2.1.1.2	First Modal Frequency	✓	A, T			Derived from SSP 57000, Section 3.1.1.4D
3.3.8.2.1	6.2.2.14	Batteries	✓	A			Derived from LS-71000, Section 6.2.2.14
3.5.2.1	7.3.3	Acceptance Data Package	✓				
3.5.2.1.1	7.3.3	ADP Statement in SOW	✓				

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX D

ACCEPTANCE AND QUALIFICATION TEST APPLICABILITY MATRICES

APPENDIX D

TABLE D-1. ACCEPTANCE AND QUALIFICATION TEST APPLICABILITY MATRIX

HRD Section	HRD Verification Section	LS-71000 Section	Requirement	Applicable	Comments
3.4.1A	4.3.1.1 and 4.3.1.2	5.4.1.1.6.1 and 5.4.1.1.6.2	Nominal Operation Under Thermal Environment	✓	
3.4.1B	4.3.1.1 and 4.3.1.2	5.4.1.1.6.1 and 5.4.1.1.6.2	Nominal Operation Under Thermal Environment	✓	
3.4.2A	4.3.2.1	5.4.1.1.2	Vibration and Sine Sweep - Sine Sweep	✓	
3.4.2B	4.3.2.2.2	5.4.1.1.3.2	Vibration and Sine Sweep - Qualification Random Vibration	✓	
3.4.2C	4.3.2.2.3	5.4.1.1.3.3	Vibration and Sine Sweep - Acceptance Random Vibration	✓	
3.4.3	4.3.3		Functional Performance	✓	
3.4.4	4.3.4	5.4.1.1.10	EEE Parts Control, Selection, and Burn-in	✓	
3.4.5	4.3.5	5.4.1.1.8	Flammability	✓	
3.4.6	4.3.6	5.4.1.1.9	Offgassing	✓	
3.4.7	4.3.7	5.4.1.1.4	Shock	N/A	
3.4.8	4.3.8	5.4.1.1.5	Bench Handling	✓	
3.4.9	4.3.9	5.4.1.1.1	Payload Mass	✓	
3.4.10	4.3.10	5.4.1.2.1	EMI/EMC	✓	
3.4.11	4.3.11	5.4.1.1.7	Acoustic Noise	✓	
3.4.12.1		5.4.1.1.11.1	Safety Critical Structure Dimensional Check	N/A	
3.4.12.2		5.4.1.1.11.2	Safety Critical Structure Material Certification	N/A	
3.4.13	4.3.12		Pre-Delivery Acceptance	✓	

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

TABLE D-2. NON-CRITICAL HARDWARE QUALIFICATION TEST REQUIREMENTS

Component / Type Test	Example Electronic Equipment	Example Mechanical Equipment	Example Battery	SEG46117400-301	Part Number	Part Number	Part Number	Part Number
Thermal Cycling 7.5 Cycles	✓	✓	✓	QATT				
Qualification for Acceptance Vibration	✓	✓	✓	QAVT				
Flammability	✓	✓	✓	A				
Offgassing	✓	✓	✓	T				
Bench Handling	✓	✓	✓	T				
Payload Mass Control Plan	✓	✓	✓	T				
EMI/EMC Control Plan	✓		✓	T				
Acoustic Noise Control Plan	✓	✓		T				
96-hour EEE Parts Screening	✓	✓	✓	T				
96-hour EEE Parts Control	✓	✓	✓	A				

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

TABLE D-3. NON-CRITICAL HARDWARE ACCEPTANCE TEST REQUIREMENTS

Component / Type Test	Example Electronic Equipment	Example Mechanical Equipment	Example Battery	SEG46117400-301	Part Number	Part Number	Part Number	Part Number
Thermal Cycling 1½ Cycles	✓	✓	✓	ATT				
Acceptance Vibration	✓	✓	✓	AVT				
Functional	✓	✓	✓	✓				
Burn-in	✓	✓	✓	✓				
Pre-Delivery Acceptance Functional	✓	✓	✓	✓				

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX E

JHB 8080.5 DESIGN GUIDANCE MATRIX

APPENDIX E

JHB 8080.5 DESIGN GUIDANCE MATRIX

✓ = Applicable N/A - Not Applicable E = Exception

	SECTION III				
		JHB 8080.5 DESIGN GUIDANCE SECTION			
No.	**Standard #**	**Abbreviated Requirement**	**App.**	**HRD Section**	**Comments**
	GENERAL				
	G-1	Equipment Access. for Maint.	✓		Maintenance Plan will be written to address all maintenance procedures
	G-2	Separation of Redundant Equip.	N/A		There are no redundant systems
	G-3	Systems Checkout Provisions	✓		Procedures will be written for check-out procedures
	G-4	Protection of Spacecraft Elect. and Mech. Systems from Debris	✓		Verify that strains are present in the drawer. Also verify PCB are conformal coated.
	G-5	Interior Design of Spacecraft for Cleanliness	N/A		Cleanliness will be defined per JHB 5322 (see HRD 4.4)
	G-6	Redundancy Requirements	N/A		The RC does not display clock time, only a duration of the run-time.
	G-7	Intermittent Malfunctions	✓		Use of Discrepancy Report (DR) System
	G-8	Redundant Paths - Verification of Operation	N/A		Not critical to flight subsystem
	G-9	Shatterable Material - Exclusion From Habitable Compartment	✓		Inspect HW Item drawings and/or hardware for shatterable material
	G-10	Control of Limited-Life Components	✓		Limited Life Items list will be generated
	G-11	Procurement Document Identification for Manned Space flight Vehicle Items	✓		Controlled via ISO procedure Safety and Product Assurance (S&PA) Quality System Instruction (QSI) 5.1
	G-12	Application of Previous Qualification Tests	N/A		RC will not use previously certified assemblies or subassemblies
	G-13	Shipping and Handling Protection for Space flight Hardware	✓		

APPENDIX E

JHB 8080.5 DESIGN GUIDANCE MATRIX (Cont'd)

✓ = Applicable N/A - Not Applicable E = Exception

	SECTION III				
		JHB 8080.5 DESIGN GUIDANCE SECTION			
No.	**Standard #**	**Abbreviated Requirement**	**App.**	**HRD Section**	**Comments**
	GENERAL				
	G-14	Identification and Classification of Flight and Non-flight Equipment	✓		Verify hdw is classified correctly
	G-15	Equipment Failure - Verification of Flight Readiness	✓		DR and Failure Investigation Analysis Report (FIAR) system in-place
	G-16	Operating Limits on Temperature - Controlled Equipment	✓		Ref. HRD, Par. 5.2 Brandon????
	G-17	Separate Stock for Space flight Parts and Materials	✓		Ref. assembly TPS and ADP
	G-18	Safety Precautions - Test and Operating Procedures	✓		Audit Test Procedures
	G-19	Special Processes - Identification of Drawings	✓		Verified during the drawing release process
	G-20	Spacecraft Equipment - Protection from System Liquids	✓		Review of Design
	G-21	Spacecraft Equipment - Moisture Protection	✓		Verify boards are conformal coated. Obtain material cert. Memo
	G-22	Parts Identification	✓		Verify all flight parts have 911 tags and are identified correctly
	G-23	Pressure Garment Wiring-Ignition of Materials by Electrical Current	✓		Not applicable to HW Item design
	G-24	GSE and ASE Protective Devices	✓		Review Ground Support Equipment (GSE) design and/or drawings
	G-25	Thermal Design and Analysis - Thermal Parameters	✓		Thermal analysis report will be generated
	G-26	Internally Generated Radiation	N/A		There are no laser sources on the RC

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	SECTION III				
		JHB 8080.5 DESIGN GUIDANCE SECTION			
No.	**Standard #**	**Abbreviated Requirement**	**App.**	**HRD Section**	**Comments**
	G-27	Fire Control	N/A		Fire control is done at the rack level
	G-28	Moisture in Window Cavities	N/A		Not applicable to HW Item design
	G-29	Thermal Blanket Venting	N/A		Not applicable to HW Item design
	G-30	Switch Protection Devices			Verify switch cannot be moved inadvertently
	G-31	Detachable Crew-Operated Tools - Restriction in Spacecraft	N/A		Not applicable to HW Item design
	G-32	Measurement Systems that Display Flight Information to the Crew - Indication of Failure	N/A		Not applicable to HW Item design
	G-33	Surface Temperatures	✓		Refrigerated surfaces are exempt. A thermal analysis will be provided
	G-34	Extravehicular Activity Electronic Connectors	N/A		Not applicable to HW Item design
	G-35	Enclosure Panels External to the Habitable Modules	N/A		Not applicable to HW Item design
	G-36	Thermal Blankets - Extravehicular Activity	N/A		Not applicable to HW Item design
	G-37	Color - Operational Significance	N/A		No EVA functions
	G-38	Color Failure (Electronic Displays)			Analysis of LED and Failure modes
	G-39	Color Assignment (Monitoring and Command Displays)	N/A		Not applicable to HW Item design
	G-40	Systems Monitoring Displays	N/A		Not applicable to HW Item design
	G-41	Emergency Lighting	N/A		Not applicable to HW Item design
	G-42	Private Quarters	N/A		HW will operate in a lower environment
	G-43	Centralized Subsystem Controls	N/A		Not applicable to HW Item design
	G-44	Module Pressure Leak Identification	N/A		Not applicable to HW Item design

JHB 8080.5 DESIGN GUIDANCE MATRIX (Cont'd)

✓ = Applicable N/A - Not Applicable E = Exception

	SECTION III				
		JHB 8080.5 DESIGN GUIDANCE SECTION			
No.	**Standard #**	**Abbreviated Requirement**	**App.**	**HRD Section**	**Comments**
	E-1	Mating Provisions for Electrical Connectors	✓		Review HW Item design and drawings
	E-2	Protection of Severed Electrical Circuits	N/A		Not applicable to HW Item design
	E-3	Electrical and Electronic Devices - Protection from Reverse Polarity and/or Other Improper Electrical Inputs	✓		Review HW Item design and drawings
	E-4	Electrical Connectors - Moisture Protection	✓		Review HW Item design and drawings
	E-5	Electrical Connectors - Pin Assignment	✓		Review HW Item design and drawings
	E-6	Corona Suppression	N/A		Not applicable to HW Item design
	E-7	Tantalum Wet Slug Capacitors - Restriction on Use	✓		Review HW Item design and drawings
	E-8	Electrical and Electronic Supplies and Loads - Verification Tests	✓		Review TPSs
	E-9	Electrical Circuits - De energizing Requirements	✓		Review drawings, design, and training procedures
	E-10	Cleaning of Electrical and Electronic Equipment	✓		Review drawings, design, PDA, and data pack
	E-11	Protective Covers or Caps for Electrical Receptacles and Plugs	✓		Review Flt. HW and GSE drawings and design
	E-12	Electrical Connect. - Disconnect. for Troubleshoot and Bench Testing	✓		Controlled by TPS and operation procedures
	E-13	Bioinstrumentation Systems - Crew Electrical Shock Protection	✓		Review design and drawings, test protection circuits as part of PDA
	E-14	Electrical Wire Harness - Dielectric Tests	✓		Ref. assembly TPS and ADP
	E-15	Electrical Power Distribution Circuits - Overload Protection	✓		Review HW Item design and drawings

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	SECTION III				
		JHB 8080.5 DESIGN GUIDANCE SECTION			
No.	**Standard #**	**Abbreviated Requirement**	**App.**	**HRD Section**	**Comments**
	E-16	Testing Protective Devices for Solid-State Circuits	✓		
	E-17	Electrically radiated and Conducted Interference	✓		EMI Test
	E-18	Alarm Power Source	N/A		Not applicable to HW Item design
	E-19	Potential Hazard of Relay/Contactor Remake	✓		Review HW Item design and drawings
	E-20	Control of Electrostatic Discharge for Electronic Parts and Assemblies	✓		Analysis of design
	E-21	Electrical Connectors	✓		
	E-22	Electronic Cooling	N/A		Not applicable to HW Item design
	F-1	Flow Restriction Requirements - Pressurized Sources	✓		Analysis will be performed
	F-2	Moisture Separators in a Zero-Gravity Environment	N/A		Not applicable to HW Item design
	F-3	Service Points - Positive Protection from Interchangeability of Fluid Service Lines	N/A		There are no service lines in the RC
	F-4	Ground Service Points - Fluid Systems	N/A		Portable systems excluded from this req.
	F-5	Fluid Lines - Separation Provisions	N/A		Fluid lines will not be disconnected in flight
	F-6	Temperature and Pressure Monitoring Requirements for Potentially Hazardous Reactive Fluids	N/A		The fluid used is not hazardous
	F-7	Capping of Servicing and Test Ports	N/A		No service lines in the RC
	F-8	Fluid System Components Whose Function is Dependent on Direction of Flow - Protection Against Incorrect Installation	N/A		Assembly instructions will be clearly marked on the assembly drwgs.

✓ = Applicable N/A - Not Applicable E = Exception

	SECTION III				
		JHB 8080.5 DESIGN GUIDANCE SECTION			
No.	**Standard #**	**Abbreviated Requirement**	**App.**	**HRD Section**	**Comments**
	F-9	Spacecraft Venting - Induced Perturbing Forces	N/A		Not applicable to HW Item design
	F-10	Nozzles and Vents - Protection Prior to Launch	N/A		Not applicable to HW Item design
	F-11	Fluid Supplies - Verification Tests	N/A		There is no fluid exchange with the spacecraft
	F-12	Protection of Pressurized Systems from Damage Due to Pressurant Depletion - Ground Support Equipment and Airborne Support Equipment	N/A		No support equipment required to operate the RC
	F-13	Habitable Module Pressure - Venting Restriction	N/A		Not applicable to HW Item design
	F-14	Habitable Module Ventilating Fans - Protection from Debris	N/A		
	F-15	Separation of Hypergolic Reactants	N/A		Not applicable to HW Item design
	F-16	Fluid Line Installation	N/A		Not applicable to HW Item design
	F-17	Cleanliness of Flowing Fluids and Associated Systems			Fluid is no a consumable
	F-18	Pressure Relief Valves - Standardization of Functional Testing	N/A		There are no pressure relief valves
	F-19	Protection for Tubing, Fittings, and Fluid System Components - Flight Hardware and Associated Equipment	✓		Charging procedures, as well as assembly drwgs., specify proper processes.
	F-20	Fluid Systems - Cleanliness	✓		Process will be stated in Refurbishment/charging procedures
	F-21	Purge Gases - Temperature and Humidity Requirements	N/A		Not applicable to HW Item design
	F-22	Pressure Garments - Protection Against Failure Propagation	N/A		Not applicable to HW Item design

JHB 8080.5 DESIGN GUIDANCE MATRIX (Cont'd)

✓ = Applicable N/A - Not Applicable E = Exception

	SECTION III				
		JHB 8080.5 DESIGN GUIDANCE SECTION			
No.	**Standard #**	**Abbreviated Requirement**	**App.**	**HRD Section**	**Comments**
	F-23	Qualification Fluid	✓		Copy of Cert. of Compliance
	F-24	Fluid Systems - Design for Flushing and Draining	N/A		There is no placed servicing of the fluid system
	F-25	Fluid Sloshing Induced Perturbing Forces	N/A		Fluid is non-toxic
	F-26	Atmospheric Pressure and Composition Control	N/A		Not applicable to HW Item design
	F-27	Potable Water	N/A		Reference 5.8F-23
	F-28	Pressure and Vacuum Gauges--GSE	N/A		Not applicable to HW Item design
	F-29	Gas Purges in Habitable Modules	N/A		?????
	F-30	Pressure Relief for Pressure Vessels	N/A		Pressure fluctuates only as a function of temperature
	F-31	Use of Halogen Method for Coolant System Leak Detection	N/A		
	F-32	Filter Protection of Active Fluid Components	N/A		
	F-33	Use of Dissimilar Metals on Electrolyte Fluid Systems	✓		Review of drawing and material cert.
	M/P-1	Material Selection, Review, and Drawing Sign-off	✓		Review HW Item Material Cert. Rpt.
	M/P-2	Flammability of Wiring Material	✓		Review HW Item Material Cert. Rpt.
	M/P-3	Toxicity of Materials Used in Crew Compartments - Wire Insulation, Ties, Identification Marks, and Protective Coverings	✓		Review HW Item Material Cert. Rpt.
	M/P-4	Metals and Metal Couples - Restriction on Use	✓		Review HW Item design and drawings

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	SECTION III				
		JHB 8080.5 DESIGN GUIDANCE SECTION			
No.	**Standard #**	**Abbreviated Requirement**	**App.**	**HRD Section**	**Comments**
	M/P-5	Solutions which contain Ethylene Glycol - Requirements for Silver Chelating Agent	N/A		Not applicable to HW Item design
	M/P-6	Toxicity-Requirements for Nonmetallic Materials Proposed for Use within Crew Compartment	✓		Review HW Item Material Cert. Rpt.
	M/P-7	Material Detrimental to Electrical Connectors	✓		Review HW Item design and drawings, material certification memo
	M/P-8	Leak Detectors - Wetting Agents	N/A		No leak detectors will be used
	M/P-9	Breathing Systems - Requirement to Test for Mercury Contamination	N/A		Not applicable to HW Item design
	M/P-10	Liquid Locking Compounds, Restrictions, and Controls	✓		Verify there is no exposed liquid locking compound exposed (assembly TPS)
	M/P-11	Stainless Steel Tubing - Method of Joining	✓		Review of drawing and assembly procedure
	M/P-12	Multi-layer Blanket Bake-Out	N/A		Not applicable to HW Item design
	M/P-13	Iodine Loss from Water System	N/A		Prakash
	M/P-14	Silicate Ester Coolant System Design	N/A		Not applicable to HW Item design
	M/P-15	Mercury - Restriction on Use	N/A		Not applicable to HW Item design
	M/P-16	Restriction on Coatings for Areas Subject to Abrasion	✓		Front panel will be a label
	M/P-17	Radiographic Inspection of Brazed and Welded Tubing Joints	✓		All tubing is less than 1/2" diameter. Inspection will be performed.
	M/P-18	Etching Fluorocarbon Insulated Electrical Wire	✓		Verify during assembly that all cables using Fluorocarbons have been etched
	M/P-19	Spacecraft Material - Restriction on Use of Polyvinyl Chloride	✓		Materials cert. Memo

✓ = Applicable N/A - Not Applicable E = Exception

	SECTION III				
		JHB 8080.5 DESIGN GUIDANCE SECTION			
No.	**Standard #**	**Abbreviated Requirement**	**App.**	**HRD Section**	**Comments**
	M/P-20	Titanium or Its Alloys - Prohibited Use with Oxygen	N/A		Titanium is not used in the RC
	M/P-21	Beryllium - Restricted Use within Crew Components	N/A		Beryllium is not used in the RC
	M/P-22	Brazed Joints - Identification Marks	✓		Not applicable to HW Item design
	M/P-23	Pressure Vessels - Materials Compatibility and Vessel Qualifications Tests	✓		An assessment will be performed by the pressure vessels group. A fracture analysis will also be performed.
	M/P-24	Cadmium - Restriction on Use	N/A		Cadmium is not used in the RC
	M/P-25	Pressure Vessels - Nondestructive Evaluation Plan			GASMAP only, part of CDR data package
	M/P-26	Repair of Sandwich -Type Structures	N/A		Not applicable to HW Item design
	M/S-1	Equipment Containers - Design for Rapid Spacecraft Decompression	✓		Review HW Item design, drawings, & test (if necessary)
	M/S-2	Alignment of Mechanical Systems	✓		Review HW Item design, drawings, & test (if necessary)
	M/S-3	Wire Bundles - Protective Coating	✓		Review HW Item design, drawings, & test (if necessary)
	M/S-4	Hatches - Repeated Use	N/A		Not applicable to HW Item design
	M/S-5	Threaded Fittings - Restrictions on Release of Particles and Foreign Material	✓		Review HW Item design and drawings
	M/S-6	Exposed Sharp Surfaces or Protrusions	✓		
	M/S-7	Windows and Glass Structure	N/A		Not applicable to HW Item design
	M/S-8	Penetration of Inhabited Spacecraft Compartments	N/A		Not applicable to HW Item design
	M/S-9	Mechanisms	N/A		Not applicable to HW Item design
	M/S-10	Container Latching Techniques			Review of Design

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	SECTION III				
		JHB 8080.5 DESIGN GUIDANCE SECTION			
No.	**Standard #**	**Abbreviated Requirement**	**App.**	**HRD Section**	**Comments**
	M/S-11	Meteoroid Protection Levels for Structures	N/A		Not applicable to HW Item design
	M/S-12	Protection of Critical Module Interfaces During Transportation, Handling, and Integration Activities	N/A		Not applicable to HW Item design
	M/S-13	Lifting and Hoisting Ground Support Equipment Identification	✓		Integrated Rack only
	M/S-14	Structural Analysis	✓		Review HW Item Stress Analysis Rpt.
	P-1	Explosive Devices - Arming and Disarming	N/A		Not applicable to HW Item design
	P-2	Pyrotechnic Devices - Preflight Verification Tests at Launch Sites	N/A		Not applicable to HW Item design
	P-3	Wire Splicing	N/A		Not applicable to HW Item design
	P-4	Explosive Devices - Packaging Material	N/A		Not applicable to HW Item design
	P-5	Explosive Devices - Identification Requirements	N/A		Not applicable to HW Item design

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